DOCUMENT RESUME

ED 077 405 HE 004 211

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TITLE	A New Variant of the Educational Opportunity Bank Designed for Stability and Ease of Administration in "Small-Scale" Application.
INSTITUTION	Pennsylvania Univ., Philadelphia. Dept. of Economics.
SPONS AGENCY	Department of Health, Education, and Welfare, Washington, D.C.
PUB DATE	30 Oct 72
NOTE	126p.
EDRS PRICE	MF-$0.65 HC-$6.58
DESCRIPTORS	Educational Economics; *Educational Finance; *Educational Opportunities; *Higher Education; Management; Program Administration; *Socioeconomic Status; *Student Loan Programs

ABSTRACT

A new variant, the Partially Contingent Educational Opportunity Bank Plan (PCEOB), of the contingent repayment loan is proposed for higher education. This report develops PCEOB operating parameters to be applied to U.S. medical schools. Part one discusses three EOB variants: semi-conventional, fully-contingent, and partially-contingent. Part two reviews calculations for each semi-conventional loan program, fully-contingent programs, and partially-contingent plans. Part three evaluates the three programs. Part four presents the pure economic theory of the ideal contingent repayment loan program. Appendices and a 12-item bibliography are included. (Author/MJM)

A NEW VARIANT OF THE EDUCATIONAL OPPORTUNITY BANK DESIGNED FOR STABILITY AND EASE OF ADMINISTRATION IN "SMALL-SCALE" APPLICATION*

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October 30, 1972

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ABSTRACT

A new variant of the contingent-repayment loan is proposed for higher education. The new variant, which we call "the Partially Contingent Educational Opportunity Bank plan," is designed to be very stable (i.e., relatively insensitive in overall operating characteristics to assumptions about basic parameters) and to economize on administrative costs, especially when applied at the institutional level rather than as a program of the federal government.

Under the Partially Contingent EOB plan, a student borrower would agree to repay his debt over a fixed period after graduation. The method of repayment would be somewhat like that of a conventional home mortgage except that coupon repayments would increase each year in accordance with expected ability to repay rather than remaining level for the entire period. There would also be low-income protection for borrowers: In each year, the PCEOB borrower would be given the option of coupon repayment (described above) or payment contingent upon his income, whichever is to his advantage. For stability and ease of administration, the well-designed PCEOB plan sets the contingency-repayment-tax rate sufficiently high so that this option is selected only by those participants with the lowest incomes. In this way, the PCEOB offers mutualization of the most salient borrower risks while minimizing administrative costs and risks to lending institutions: The borrower is given protection from full repayment when his income turns out to be very much less than could be anticipated, probably the student's greatest worry about the "albatross" of repayment commitment. Because most borrowers will elect the noncontingent

coupon method of repayment, the lending institutions can very accurately predict the stream of annual repayments from any graduating class. Also, because few borrowers will elect the contingency option, the administrative costs to the lending institution of verification of individual borrowers' incomes would be substantially less than in a program where all incomes had to be verified.

In this report we develop PCEOB operating parameters to be applied to US Medical Schools. Given the required rate-of-return, r, (or break-even interest rate) and the low-income-contingency-repayment-tax rate, τ, we solve for the required coupon interest rate, r_c, which determines repayments for borrowers not electing the contingency option. (Study, for example, Figure II, page 43.) For the well-designed plan the coupon rate of interest, r_c, is only slightly greater than the overall rate of return, r. E.g., in Figure II, if the overall rate of return, r = 6% and the income-contingent-repayment-tax rate is .2% per $1,000 borrowed, then the coupon interest rate, r_c, should be set at 6.17%, only .17 percentage points higher than r. This means that the borrower who turns out to have had high incomes in each repayment year, and therefore has never elected the contingency option, pays an additional .17% in interest rate in order to offset "losses" from the low-income borrowers. If we like, the additional .17 percentage points in interest rate could be thought of as the borrower's insurance premium - insurance against his having income substantially below the average expected income of his graduating class. (The only difference between the terms of this insurance and more conventional insurance policies is that in this case the "premium" is paid by those who have avoided the risk and to some extent only after the insurance period is over.)

A widespread worry about the stability of any contingent repayment loan scheme centers on the question of adverse-self selection by borrowers: The problem that students with poor income prospects might participate in the program with greater frequency than students with good income prospects. We do not see this as a problem for the PCEOB with a coupon rate of interest which is attractive compared to other interest rates facing the borrower. Nonetheless, we have tested the effect of various (rather extreme) adverse self-selection scenarios on the PCEOB. (See, e.g., Figures III and IV, pages 45 and 46.) If adverse self selection is anticipated by the lending institution then the coupon rate, r_c, must be higher than without adverse selection in order to achieve the same overall rate of return, r. r_c is relatively insensitive to adverse selection scenario, see Figure III where at expected income growth rate of 4% even the most extreme anticipated adverse selection (no participants with above median income!) does not increase r_c by as much as a percentage point. From Figure IV we see that the plan is also relatively insensitive to unanticipated adverse selection. If the lender is expecting a return of 6% (at income growth rate of 4%) then even the most extreme adverse selection scenario will yield an overall rate of return, r, greater than 5 1/2%. The PCEOB is also stable with respect to assumptions about income growth rates (Figures III and IV) but when poor income growth rate forecasting is combined with a very extreme adverse selection scenario, the unanticipated shortfall in overall rate of return could nearly reach two percentage points.

The partially contingent (PCEOB) is compared to two other EOB variants: (1) The "fully contingent" variant (essentially the Shell-Zacharias version) and (2) the "semi-conventional" variant (the PCEOB without the contingency option). The fully contingent plan offers the greatest mutualization of risk to the borrower while imposing the most administrative cost on the lender since all borrower incomes are subject to verification. In practice, the fully contingent plan seems to be only slightly less stable in the face of adverse selection than the partially contingent plan. The semi-conventional plan is studied as a benchmark. It is the easiest program to administer, the most stable and offers no mutualization of borrower risk, all because there is no provision for income-contingent repayment.

A brief theoretical section relates the particular applied problem to the pure theory of optimal adverse risk selection, a problem in control and decision-making under uncertainty. Also included is reference to administrative and transactions costs in the theory of equilibrium.

Our basic computer programs are catalogued in several appendices. One appendix attempts to survey the recent (and very rapidly unfolding) experience with pilot-project contingent repayment loan schemes in American higher education.

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INTRODUCTION

We have designed a new variant of the education loan in which repayments are contingent on the borrower's lifetime income stream. We call this variant "the partially contingent Educational Opportunity Bank plan." It has three important properties: (1) relative stability (or insensitivity) of the rate-of-return to assumptions about underlying parameters, (2) relative ease and economy of administration on a smaller-scale or pilot-project basis, while (3) offering much of the income insurance and psychological protection for borrowers provided by earlier EOB proposals. Most noteworthy is the strong stability of the partially contingent program to assumptions about adverse self-selection by EOB participants. We compare the partially contingent variant to two other variants: (1) the "semi-conventional variant," which economizes most on administration costs and is most stable but provides the least insurance for participants, and (2) the "fully contingent variant," which provides the most insurance for participants, but is least economical to administer and is the least stable, (i.e., the most sensitive to assumptions about underlying parameters.)

The Educational Opportunity Bank proposal has been a subject of intensive debate within American higher education ever since the 1967 release of the Report of the Panel on Educational Innovation [3]. Two National Tax Journal articles, Shell et. al. [11] in 1968 and Shell [10] in 1970, attempted to sharpen the basis for debate over fundamental issues in higher education finance by providing detailed economic analyses of and "hard numbers" for the Ed Op Bank proposal.

The general Ed Op Bank concept, that students have the opportunity to contract for educational loans which may be repaid over relatively long periods, contingent upon the borrower's lifetime income stream, has by now become a reality on some university campuses.[1] Financial pressure has forced educational institutions to set up their own pilot-project Ed Op Banks.

By contrast, the original proposals had envisioned a federally operated Ed Op Bank which would coordinate its activities with the Internal Revenue Service. Coordination with the IRS would make the contingent-repayment feature relatively easy to enforce since the IRS would have income tax returns at its disposal for crosschecking. Indeed, it was suggested that[2] Ed Op repayments be collected by the IRS in conjunction with the collection of personal income taxes.[3] It was argued, therefore, that <u>economic transactions costs</u> - including costs of <u>collection</u> and <u>enforcement</u> - would be relatively small for the <u>nationally operated Ed Op Bank</u>.

On the other hand, there is no reason to expect transactions costs necessarily to be small for independently operated or pilot-project contingent-repayment loan schemes. In these cases, "true copies" of IRS Form 1040 are not available for confirmations of the incomes on which repayments will be based.[4] If the borrower's statement of income is not to be taken on face value, costly investigation and perhaps legal fees must be incurred by the scheme. Furthermore, independent mailings

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1 See Appendix D for a brief survey and history of implementations and attempted implementations of income contingent loan repayment plans for higher education.

2 See, Shell <u>et. al.</u> [11].

3 The thought was that Form 1040 could accomodate the collection of Ed Op repayments after adding a few extra lines.

4 It has come to our attention that participants in Yale's Deferred Tuition Plan give Yale the right of receiving true 1040 copies from the IRS. The IRS would charge Yale for each investigation. This is obviously a costly procedure but is perhaps less costly than we seem to imply in the text.

and record-keeping are costly to the lending institution. If the relatively small scale contingent loan scheme is looked upon as a test or pilot project pointing toward the possibility of ultimately adopting the principle on national scale, then a strong case can be made for "outside" support of administrative, research, and those transactions costs expected to disappear when the schemes "go national" and coordinate with the Internal Revenue Service. It seems to us that support of administrative, research, and transactions (collection and enforcement) costs in pilot-project contingent-repayment loan schemes is a proper rôle for the federal government and private philanthropy.

The federal government and private philanthropy have so far been reluctant to provide such support. It is essential, therefore, that the Ed Op Bank be redesigned for smaller-scale application with a view to substantially reducing transactions costs.

We present in this paper a variant of the Ed Op Bank which we call the "partially contingent" scheme.[1] If the operating parameters of this variant are chosen correctly, only a small percentage (between, say, 10% and 30%) of participants are expected to elect repayment contingent upon income. For this reason, enforcement costs and risk to the smaller-scale lending institution can be substantially reduced. In designing the "partially contingent" program, we retain attractive features of the original (or "fully contingent") EOB scheme: (1) The long repayment period (of, say, 20 or 30 or more years) is an essential part. (We even consider the new feature of an after-graduation grace period.[2])

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[1] After completing this study, it has come to our attention that the Ford Foundation PAYE group has proposed a somewhat similar plan which they call their "hybrid" plan. See Pay-As-You-Earn, Ford Foundation Studies in Income Contingent Loans for Higher Education: Summary Report and Recommendations, New York, 1972. Also the forthcoming New Patterns for College Lending: Income Contingent Loans by D. Bruce Johnstone assisted by S. P. Dresch, Columbia University Press.

[2] We understand that Duke University offers a repayment grace period in the terms of their current tuition postponement plan.

(2) Expected repayment increases through time for each borrowing cohort.

(3) Insurance against low future income for any participant is retained, but in a simpler form. Only those participants who fall into what is expected to be the lowest few income deciles of [illegible] rowing cohort will base their repayments on income. All others pay a prearranged "coupon rate" per $1,000 borrowed. Unlike the conventional mortgage repayment, coupon repayments are not equal over the life of the loan but instead increase at an exponential rate to accomodate the typical borrower's "ability to pay."

Our "partially contingent" variant is precisely defined in what follows. Its operating characteristics are studied and compared to those of the "fully contingent" variant - essentially the schemes studied by Shell et. al. [11] and Shell [10] and what we call a "semi-conventional" variant - essentially the "partially contingent" variant without the income contingent provision but with the long repayment period and exponentially increasing repayments geared to expected ability to repay.

The "stability" properties of an EOB scheme are of great importance. Any lender, including the federal government, must be concerned with the robustness of expected rate-of-return to assumptions about growth-of-incomes, adverse selection of participants,[1] and so forth. For a variety of reasons, "stability" considerations seem to be more important for the smaller-scale EOB than for the federal EOB: (1) The smaller-scale EOB must be more adverse to financial risk than would a federal EOB because of its relatively small financial base. (2) Because it must support relatively greater administrative and transaction costs and because it

[1] There is said to be adverse selection of participants when the average income prospects of participants is poorer than that of the college class as a whole.

must borrow money at higher interest rates than the federal government, the smaller-scale EOB will probably seek a higher gross rate-of-return than is envisioned for the national EOB. This, in turn, accentuates the problem of adverse self-selection by participants in the smaller-scale EOB.

Our partially-contingent variant is very robust to assumptions about underlying parameters, especially to assumptions about adverse self-selection by participants. This is another reason why the partially contingent variant should be especially attractive to the smaller-scale EOB. Since stability is also important for the national EOB (but not as vital as it is for the smaller-scale EOB), the partially-contingent variant may also prove to be attractive for any federally-sponsored program.[1]

Our calculations are based on United States medical school data. At the time we began this study, it seemed to us that we might find our first practical EOB applications in this area.[2] In retrospect, this choice appears less than ideal since medical schools as a group now seem to be more resistant to EOB proposals than the other professional schools

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1 Shell [10] shows that the fully contingent EOB has a stable rate-of-return with respect to what seems to us to be quite extreme assumptions about adverse self-selection of participants. Nonetheless, Hartman [5] and Nerlove [8] express nervousness about the adverse-self-selection problem. Perhaps they will find our partially-contingent variant so stable that adverse self-selection will no longer be considered an issue. In what follows, we clarify aspects of the adverse self-selection problem for it, *per se*, does not entail problems, but coupled with poor income forecasting, it could.

2 See Shell [9] and Shell [10].

and even some undergraduate colleges. This study stands as a possible guide to medical schools should they turn to this option. More importantly, we hope this study will be of general use in higher education finance;[1] only the data are specific to the medical school case.[2]

We conclude our analysis by relating our underlying and basic problem, the design of an optimal Educational Opportunity Bank, to the recent theoretical literature on optimal adverse risk selection; see, e.g., Akerlof [1] and Arrow [2], optimal income taxation; see, e.g. James Mirrlees [7] and Eytan Sheshinski [12], and economic equilibrium with transactions costs, see, e.g., Foley [4] and Heller [6]. It turns out that the concepts needed for our purposes are just those touched upon by Kenneth Arrow [2] in his remarks on the new theory of optimal adverse-risk selection.

I. The Three EOB Variants

We consider and compare three related loan repayment schemes: a "semi-conventional" plan, a "fully contingent" plan, and a "partially contingent" plan. In all cases, loans are made in the same way; only the way in which loans are repaid distinguishes one plan from the others.

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1 This study is part of a larger report being prepared for the U.S. Department of Health, Education, and Welfare. The larger report will tabulate all our basic computer programs. Users can test their own data on these programs. When available, the larger report can be obtained by writing to Professor Karl Shell, Department of Economics, University of Pennsylvania, Philadelphia, Pa. 19104.

2 However, recent developments among medical schools such as that of the University of Pennsylvania suggest that state legislatures are increasingly unwilling to finance the education of MD's who do not practice in the state in which the university is located. Hence, the proposal seems to have as much *a priori* appeal as ever. See also Appendix D for a summary of proposals.

Loans are extended to all participants at the beginning of each medical school year. Graduates borrow in each of the four years of medical education, while those who drop out only borrow during their actual enrollment years. (Assumed to equal 2 years) For all participants, interest accrual begins immediately and continues throughout medical school and the ensuing repayment period.

We distinguish borrowers by three classifications in each "cohort," or entering class: income decile, educational achievement (medical-school graduate or dropout), and age (25-64 years). This is the DEA nomenclature of the undergraduate program (see Shell et. al. [11]). Thus, marital status and sex are not elements considered in the present study even though the incomes of female physicians are relatively low. However, we examine the returns of all physicians, in the aggregate, since at least at present female medical students are few in number and, most importantly, since female MD's can be assumed to pursue more or less full-time careers.

Since the medical student's income is likely to be low for a few years after graduation, when he is in the military or in internship, we vary the year in which the repayment period begins. In our computations, we considered at least three alternatives:

(a) repayment begins one year after graduation (at the end of the first year out of medical school; this adds one year's accumulated interest - no grace period);

(b) repayment begins three years after graduation (two-year grace period);

and (c) repayment begins five years after graduation (four-year grace period).

The required parameters for a program utilizing the two-year grace period lie midway between those of programs with no grace period and those with a four year grace period, and thus simulation results for that alternative are presented below only to illustrate aspects of the partially contingent variant.

A. The Semi-Conventional Variant

In this variant there is no income contingency provision. Thus, while no insurance is provided the student borrower, the lender is only exposed to risks from default and - if the lender has borrowed short-term to finance the loan portfolio - risk of increases in the short-term interest rate.[1] The borrower is required to repay his loan plus interest over a given period of time. The semi-conventional loan is thus like a conventional home mortgage, but the repayments stream is not necessarily level during the repayment period. Indeed, in the examples studied here repayments grow at an exponential rate roughly equal to the expected average rate of growth of income for the borrower's cohort, or medical school class.

Our major purpose in examining the semi-conventional repayment scheme is to compare and contrast its terms with those of the other two plans. Notice, however, that its repayment terms are in some ways more favorable to the borrower than existing loan opportunities. Its terms differ from a commercial bank loan in the following ways:

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1 Yale is currently borrowing on a very short term basis - semiannually - to finance its "Postponed-Tuition" loan program.

- the borrower gets a longer repayment period (twenty to thirty years after graduation) than currently available from commercial sources (five to ten years after graduation);
- the borrower has the option of a "grace period," i.e., delay after graduation before beginning repayments;
- the borrower's repayments will grow over time roughly in accord with his expected income growth rather than being maintained at a constant amount.

The first feature makes this repayment scheme closer to that of a home mortgage loan than to a normal bank loan, while the third feature allows repayments to grow roughly with average cohort incomes, reflecting expected ability to pay.

B. The Fully Contingent Programs

Under the "fully contingent plan," the borrower agrees to pay in each of the years of the stated repayment period a fixed fraction of his income in that year. To lessen the impact of adverse self-selection, an opt-out provision is included in the fully contingent plan: no borrower will ever repay more than principal plus interest calculated at the annual rate R, the opt-out interest rate.[1,2] The plan analyzed here and applied to medical education is the same as that described in detail and applied to undergraduate education by Shell et. al. [11] save for: (1) inclusion in this study of a grace period in which repayment-taxes are not collected, and (2) equal treatment in this study regardless of sex or martial status, while the undergraduate study

1 Making "fully contingent" something of a misnomer.

2 Adverse self-selection occurs when those with poorer income prospects change to participate more frequently than the members of the class with higher income prospects.

provided for special tax-repayment treatment for married women. It has been shown in Shell [10] and replicated in this study's results that the fully contingent plan, with the opt-out provision, generates a rate of return which is quite insensitive to unanticipated adverse self-selection.

C. The Partially Contingent Program

The partially contingent program, which can be thought of as the result of merging features of the semi-conventional plan with features of the fully contingent plan, will be the focus of much of our analytic and empirical investigation. The partially contingent scheme allows each borrower, at the end of each (annual) repayment period, to elect one of two alternative repayments: τ multiplied by his current income Y_t, (τY_t),or the "coupon" from a semi-conventional loan repayment schedule. (Both τ and the "coupon" are set for a $1,000 loan; larger loans increase τ and the "coupon" proportionately.) We expect that low-income earners will choose the former, and that those in higher deciles will opt for the coupon, so that the i^{th} physician's repayment (per thousand dollars borrowed) in period t, P_t^i, may be represented by $P_t^i = \min(\tau Y_t^i, C_t)$, where C_t is the coupon repayment in period t.[1,2] In this program, τ must be set substantially higher than that of a fully

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1 This is a conservative assumption. Documentation would be required for contingent repayment. To avoid the effort of documentation, an MD close to the margin (where $\tau Y_t^i = C_t$) could be expected to choose coupon repayment even though $\tau Y_t^i < C_t$.

2 To protect against possible ambiguities, we will follow the convention that year of repayment, t , will always be relative to the beginning of the repayment period itself (<u>after</u> the borrowing period <u>and</u> grace period.)

contingent scheme earning a comparable rate of return to guarantee that the income-contingent repayment option will be elected only by those participants falling in the lowest few income deciles.

Why is "low contingency" desirable? The coupon program is very simple to administer, whereas tax repayments require both verification of income tax returns and individualized computation of tax. Hence, the fewer participants who elect the income contingency option, the lower the resultant administrative costs will be. Among partially contingent plans yielding the same overall rate of return r, the required rate of interest r_c of the coupon schedule is inversely related to the repayment tax rate τ. Decreasing τ decreases the dollar repayments for individuals electing the income contingency option and thus increases the frequency of election of this option. Therefore, if τ is decreased, ceteris paribus, then r_c must be increased sufficiently to offset the loss of revenue from lower individual repayments under the contingency option and from increased frequency of election of this contingency option which allows the participant to make a smaller payment than is required by the coupon option. As r_c approaches r (from above), τ must become very large to choke off election of the contingency option. It is infeasible to set the coupon rate of return below the overall rate of return ($r_c < r$).

On the other hand, if τ is relatively large, then r_c will be relatively insensitive to a change in τ because of the low frequency of election of the contingency option. In designing the "optimal" partially contingent scheme, the overall required rate of return, r, can be thought of as exogenously given by, say, the lending institution's cost of capital. There is a set of τ and r_c that are compatible with the given r.

Among these feasible (τ, r_c) pairs, the policy-maker will choose τ to be sufficiently large so as to limit expected frequency of election of the contingency option to a manageable level from the point of view of the lender's costs of administration. Since when τ is high fewer elect the contingency option, high τ's tend to make the program relatively insensitive to unanticipated changes in structure, e.g., changes in the rate of growth of incomes or changes in the pattern of adverse self-selection. However, the higher τ, other things being equal, the less income insurance is afforded participants. This then is the trade-off for the policy-maker: the higher τ, the greater the stability and ease of administration, but the lower the income insurance protection afforded to participants.

It is our feeling that a well-designed program has the following approximate characteristics: (1) τ is sufficiently high so that only the lowest few deciles (say the lowest two or three deciles) elect the income contingency option on anything like a regular basis and thus (2) the coupon rate is not very much greater than the overall rate of return. In practice, we focus on programs in which the difference, r_c-r, is roughly between 1/10% and 1%. Such programs, it seems to us, provide much of the most desirable income insurance protection provided by the less stable and more costly-to-administer fully contingent plan.

In judging whether or not a repayment commitment can be an "albatross around his neck," the potential borrower is most likely to focus on what would happen to him in very low income situations. This may be especially the case for the borrower from a low-income family. Such a borrower may be unfamiliar with the high incomes available to members of his profession and may be particularly naive about financial arithmetic and the "miracle of compound interest" as it applies to expected income growth. It seems to us that insurance of the form "you need never pay more than τ per cent of your income for each thousand dollars borrowed" should provide very strong psychological assurance to potential borrowers.[1]

II. Calculations

A. Semi-conventional loans

The most important single parameter for the semi-conventional program is the interest rate or rate of return, r. Since this program allows no income contingency, r can be also thought of as the coupon rate of interest, the overall rate of return, and the opt-out interest rate, since all these rates are the same in this simple program. The semi-conventional loan is fully described by specification of the parameters: r, T, t, and γ. T is the length of the repayment period, t is the length of the grace period after graduation in which repayments are not made, and γ is the prespecified constant annual rate of increase in repayments.

For example, when $T = 25$ years, $t = 0$, $\gamma = 10\%$, and $r = 6\%$, the starting repayment per $1,000 borrowed would be $31.56. The effects of the grace period are substantial, since interest accumulates continually. When $t = 4$ years, the initial payment rises to $40.57. In both cases, this starting payment and the remainder of the repayment stream are like coupons in a booklet for a mortgage loan - except each

[1] We are aware that important questions of psychological fact are involved here. We urge study of these questions. At this time we put forward our strong *a priori* beliefs about the role of risk aversion in the student-loan participation decision.

TABLE I-A

SEMI-CONVENTIONAL LOAN PROGRAM

FIXED REPAYMENTS GROW AT 0.0 % = y
FROM STARTING PAYMENT OF $ 92.73
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 0 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
INTEREST RATE = 6.0000% = r

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	24999.99	0.0	26499.99	1500.00	-1500.00	-26499.99
1975	24999.99	0.0	54599.98	3000.00	-3000.00	-28000.00
1976	22750.00	414.55	81563.75	4638.39	-4223.84	-26973.84
1977	22750.00	415.82	110156.69	6258.82	-5843.00	-28593.00
1978	0.0	8808.95	107957.13	6609.40	2199.55	2199.55
1979	0.0	8793.34	105641.19	6477.43	2315.91	2315.91
1980	0.0	8777.75	103201.88	6338.47	2439.28	2439.28
1981	0.0	8762.46	100631.50	6192.11	2570.35	2570.35
1982	0.0	8747.13	97922.25	6037.89	2709.24	2709.24
1983	0.0	8731.94	95065.69	5875.44	2856.50	2856.50
1984	0.0	8716.53	92153.06	5703.95	3012.58	3012.58
1985	0.0	8701.22	88975.00	5529.19	3172.03	3172.03
1986	0.0	8682.86	85524.63	5332.51	3350.35	3350.35
1987	0.0	8664.48	81991.63	5131.49	3532.99	3532.99
1988	0.0	8646.14	78264.94	4919.51	3726.63	3726.63
1989	0.0	8627.78	74333.06	4695.91	3931.87	3931.87
1990	0.0	8609.42	70183.63	4460.00	4149.42	4149.42
1991	0.0	8582.09	65812.56	4211.04	4371.05	4371.05
1992	0.0	8554.77	61206.57	3948.78	4606.00	4606.00
1993	0.0	8527.44	56351.55	3672.42	4855.02	4855.02
1994	0.0	8500.10	51232.56	3381.12	5119.00	5119.00
1995	0.0	8472.79	45833.76	3073.99	5398.80	5398.80
1996	0.0	8430.12	40153.69	2750.05	5680.07	5680.07
1997	0.0	8387.41	34175.53	2409.24	5978.16	5978.16
1998	0.0	8344.74	27881.35	2050.56	6294.18	6294.18
1999	0.0	8302.04	21252.21	1672.90	6629.14	6629.14
2000	0.0	8259.36	14268.02	1275.16	6984.20	6984.20
2001	0.0	7805.75	7318.38	856.11	6949.64	6949.64
2002	0.0	7741.30	16.21	439.13	7302.17	7302.17

TABLE I-B

SEMI-CONVENTIONAL LOAN PROGRAM

FIXED REPAYMENTS GROW AT 0.0 % = Y
FROM STARTING PAYMENT OF $ 118.54
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
INTEREST RATE = 6.0000% = r

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	24999.99	0.0	26499.99	1500.00	-1500.00	-26499.99
1975	24999.99	0.0	54590.98	[illegible]	[illegible]	[illegible]
1976	22750.00	0.0	81980.21	4640.39	-4640.39	-27390.39
1977	22750.00	0.0	111014.06	6283.81	-6283.81	-29033.81
1978	0.0	0.0	117674.88	6660.84	-6660.84	-6660.84
1979	0.0	0.0	124735.31	7060.49	-7060.49	-7060.49
1980	0.0	528.74	131690.69	7484.12	-6955.38	-6955.38
1981	0.0	527.81	139064.31	7901.44	-7373.63	-7373.63
1982	0.0	11181.77	136226.38	8343.86	2837.91	2837.91
1983	0.0	11162.20	133237.75	8173.58	2988.62	2988.62
1984	0.0	11142.66	130089.21	7994.27	3148.39	3148.39
1985	0.0	11123.06	126771.56	7805.37	3317.70	3317.70
1986	0.0	11099.61	123278.25	7606.30	3493.31	3493.31
1987	0.0	11076.11	119598.81	7396.70	3679.41	3679.41
1988	0.0	11052.66	115722.06	7175.94	3876.72	3876.72
1989	0.0	11029.19	111636.10	6943.34	4085.86	4085.86
1990	0.0	11005.74	107328.63	6698.18	4307.56	4307.56
1991	0.0	10970.79	102797.56	6439.73	4531.05	4531.05
1992	0.0	10935.84	98029.56	6167.87	4767.97	4767.97
1993	0.0	10900.91	93010.44	5881.79	5019.13	5019.13
1994	0.0	10865.99	87725.06	5580.64	5285.34	5285.34
1995	0.0	10831.06	82157.50	5263.52	5567.54	5567.54
1996	0.0	10776.50	76310.44	4929.47	5847.03	5847.03
1997	0.0	10721.93	70167.13	4578.65	6143.27	6143.27
1998	0.0	10667.36	63709.82	4210.05	6457.30	6457.30
1999	0.0	10612.81	56919.63	3822.62	6790.19	6790.19
2000	0.0	10558.24	49776.59	3415.21	7143.04	7143.04
2001	0.0	10471.77	42291.45	2986.62	7485.14	7485.14
2002	0.0	10385.32	34443.64	2537.52	7847.81	7847.81
2003	0.0	10298.88	26211.41	2066.65	8232.23	8232.23
2004	0.0	10212.43	17571.70	1572.72	8639.71	8639.71
2005	0.0	9648.84	9077.19	1054.33	8594.50	8594.50
2006	0.0	9525.20	-9.34	538.66	8986.54	8986.54

TABLE I-C

SEMI-CONVENTIONAL LOAN PROGRAM

FIXED REPAYMENTS GROW AT 10.00% = Y
FROM STARTING PAYMENT OF $ 31.56
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 0 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
INTEREST RATE = 6.0000% = r

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	24999.99	0.0	26499.99	1500.00	-1500.00	-26499.99
1975	24999.99	0.0	54589.98	3090.00	-3090.00	-28090.00
1976	22750.00	141.77	81838.50	4640.39	-4498.62	-27248.61
1977	22750.00	155.67	110709.06	6275.30	-6119.63	-28869.63
1978	0.0	3027.73	114322.81	6642.49	-3614.75	-3614.75
1979	0.0	3324.61	117857.56	6859.37	-3534.76	-3534.76
1980	0.0	3650.58	121378.44	7071.46	-3420.88	-3420.88
1981	0.0	4009.63	124546.50	7276.71	-3269.07	-3269.07
1982	0.0	4401.79	127617.50	7472.79	-3071.01	-3071.01
1983	0.0	4833.48	130441.06	7657.05	-2823.57	-2823.57
1984	0.0	5307.50	132969.00	7826.46	-2519.96	-2519.96
1985	0.0	5828.00	135109.56	7977.60	-2149.61	-2149.61
1986	0.0	6397.25	136918.88	8126.58	-1729.32	-1729.32
1987	0.0	7022.11	138005.88	8209.14	-1187.02	-1187.02
1988	0.0	7707.94	138578.25	8280.36	-572.42	-572.42
1989	0.0	8460.72	139432.19	8314.70	146.02	146.02
1990	0.0	9286.97	137451.13	8305.95	981.03	981.03
1991	0.0	10193.23	135514.94	8257.09	1936.14	1936.14
1992	0.0	11165.91	132479.94	8130.91	3034.99	3034.99
1993	0.0	12243.25	129185.51	7948.82	4294.43	4294.43
1994	0.0	13424.41	122452.19	7691.15	5733.27	5733.27
1995	0.0	14719.34	115079.94	7347.15	7372.19	7372.19
1996	0.0	16109.70	105875.00	6904.82	9204.88	9204.88
1997	0.0	17630.94	94596.56	6352.53	11278.41	11278.41
1998	0.0	19295.32	82377.06	5675.82	13619.49	13619.49
1999	0.0	21116.25	64719.46	4858.66	16257.60	16257.60
2000	0.0	23109.40	45494.27	3883.20	19225.20	19225.20
2001	0.0	23787.78	24436.18	2729.69	21058.09	21058.09
2002	0.0	25950.51	-48.12	1466.21	24484.30	24484.30

TABLE I-D

SEMI-CONVENTIONAL LOAN PROGRAM

FIXED REPAYMENTS GROW AT 10.00% = Y
FROM STARTING PAYMENT OF $ 40.57
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
INTEREST RATE = 6.0000% = r

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	24999.99	0.0	26499.99	1500.00	-1500.00	-26499.99
1975	24999.99	0.0	54599.98	3000.00	-3000.00	-28000.00
1976	22750.00	0.0	81990.31	4640.39	-4640.39	-27390.39
1977	22750.00	0.0	111014.06	6283.81	-6283.81	-29033.81
1978	0.0	0.0	117674.88	6660.84	-6660.84	-6660.84
1979	0.0	0.0	124735.31	7060.49	-7060.49	-7060.49
1980	0.0	182.96	132038.44	7484.12	-7303.16	-7303.16
1981	0.0	198.71	139762.00	7922.31	-7723.61	-7723.61
1982	0.0	3864.81	144282.88	8385.73	-4520.91	-4520.91
1983	0.0	4243.84	148696.00	8656.98	-4413.14	-4413.14
1984	0.0	4660.04	152957.69	8921.77	-4261.73	-4261.73
1985	0.0	5117.03	157018.13	9177.47	-4060.44	-4060.44
1986	0.0	5616.86	160922.31	9421.10	-3904.25	-3904.25
1987	0.0	6165.46	164326.19	9649.36	-3483.90	-3483.90
1988	0.0	6767.64	167396.94	9858.35	-3090.75	-3090.75
1989	0.0	7428.58	170012.19	10043.93	-2615.25	-2615.25
1990	0.0	8154.06	172058.81	10200.75	-2046.69	-2046.69
1991	0.0	8940.99	173441.38	10323.55	-1382.56	-1382.56
1992	0.0	9803.76	174044.06	10406.50	-602.74	-602.74
1993	0.0	10749.66	173737.06	10442.66	307.00	307.00
1994	0.0	11786.73	172374.56	10424.24	1362.49	1362.49
1995	0.0	12923.72	169793.31	10342.49	2581.23	2581.23
1996	0.0	14144.43	165936.50	10187.62	3956.81	3956.81
1997	0.0	15530.12	160306.56	9956.31	5573.81	5573.81
1998	0.0	16941.45	152983.50	9618.41	7323.06	7323.06
1999	0.0	18540.27	143622.25	9179.33	9361.25	9361.25
2000	0.0	20289.42	131950.13	8617.35	11672.07	11672.07
2001	0.0	22135.59	117731.56	7917.03	14218.56	14218.56
2002	0.0	24148.09	100647.38	7063.91	17084.18	17084.18
2003	0.0	26341.76	80344.44	6038.87	20302.89	20302.89
2004	0.0	28732.70	56432.43	4820.69	23912.01	23912.01
2005	0.0	29569.11	30249.30	3385.97	26183.13	26183.13
2006	0.0	32109.22	-44.93	1814.99	30294.23	30294.23

payment is larger than the one preceding. To illustrate the effects [illegible] in repayments, we drop γ to zero - all payments are thus equal. For the above two grace period variants, <u>ceteris paribus</u>, when $\gamma = 0\%$, the respective starting (and all succeeding) repayments are \$92.73 and \$118.54. Over 25 years, the MD would pay over \$600 extra in interest for the privilege of a four year grace period, per \$1,000 borrowed, when all payments are equal ($\gamma = 0$). To compare these repayment schedules with repayment terms more generally available today, if the repayment period (T) were shortened to ten years, with $\gamma = 0$, $t = 0$, and $r = 6\%$, repayments would be \$158.96 per year per \$1,000 borrowed.

Tables I(a) through I(d) present the cash flows resulting from these four parameter combinations in the semi-conventional repayment plan. The parameters which are operative in each plan are outlined above the cash flow table, all parameters being held constant except the starting payment, which is solved for by an iterative process. These cash flows also illustrate our basic experimental design:

a. 100 borrowers (91 graduates and 9 dropouts)

b. \$250 loan per year for each borrower

c. Graduates borrow 4 years, dropouts borrow 2 years

d. Mortality considerations - see Appendix B (note slight decrease in dropouts' repayments from 1976 to 1977 and continual decrease in repayments for grads and dropouts from 1978 on - in the equal repayments design, $\gamma = 0\%$)

e. Repayment period (if no grace period) begins immediately after year of graduation or of dropping out (thus drop-outs start and end repayments two years before graduates)

It is instructive to note the starting payment and maximum outstanding debt in each of these four programs for the above group of 100 borrowers entering medical school in the year 1974:

t	T	γ	Starting Payment	Max Outs Debt (Year) In Thousands of Dollars	
0	25	0%	92.73	110	(1977)
4	25	0%	118.54	136	(1982)
0	25	10%	31.56	138	(1988)
4	25	10%	40.57	174	(1992)

Of course, equal repayments (and thus high starting payment) with no grace period require the least outstanding debt, as bank receipts begin reduction of principal immediately after graduation (1977). It must be stressed that all four programs yield a 6% return over the 25-year repayment period, only the timing of repayments (and thus the interest charges) differ.

B. Fully Contingent Program

The results of our tax and interest rate calculations for the fully contingent scheme are presented in Tables III and IV. The fully contingent program is precisely described by the parameters τ, g, R, r, T and t, where τ is the repayment tax rate per $1,000 borrowed, g is the growth rate of incomes assumed for the borrowing cohort, R is the opt-out rate of interest at which a borrower may exit from the program before T years have elapsed, and the other parameters are the same as in the semi-conventional variant. Given a desired (r, R) pair, τ is the single most important decision parameter, and it is the one for which we solve, given the others (Naturally g is not a policy parameter, but it is nonetheless an exogenous parameter of the program).

The annual payment made prior to opting out in year x of the repayment period for a borrower in the ith income decile (per $1,000 borrowed at the end of medical school), P_x^i,[1] will be τY_x^i. Hence, outstanding debt of such an individual in year T_j in thousand dollars calculated at the opt-out rate R is equal to

$$\tilde{B}^i - \sum_{\theta=1}^{\theta=T_j} (1 + R)^{-(\theta+t)} \tilde{B}^i \tau Y_\theta^i \equiv B^{*i}(T_j)$$

where $T_j < T_i \leq T$, T_i is the opt-out year, and $\tilde{B}^i$ in the graduation debt in thousands of dollars of individual i. In the opt-out year, T_i, $B^{*i}(T_i) \leq 0$, while $B^{*i}(T_j) > 0$ for $T_j < T_i$. In year T_i payments are reduced so that the equality $B^{*i}(T_i) = 0$ holds. If $T_i < T$, this individual opts out, and if $T_i \geq T$, he does not. Actually, interest must be paid on the first year's loan during the four years in medical school, on the second year's loan for the next three years, and so on, it being assumed that the loan is evenly distributed over four years of medical school, so that

$$\tilde{B}^i = 250 \quad B^i[\sum_{j=1}^{4} (1+R)^j],$$

where B^i is the number of thousands of dollars actually borrowed exclusive of interest accumulated during medical school.

Medical school drop-outs (assumed to leave school after their second year and enter repayment period immediately)[2] must "solve for" T_i, their opt-out year, such that

$$250 \; B^i[\sum_{j=1}^{2} (1+R)^j] \leq \frac{1}{2} \tau \; B^i \sum_{\theta=1}^{T_i} [(1+R)^{-(\theta+t)} Y_\theta^i].$$

1 See Page 11 for explanation of P_x notation.

2 This differs from the undergraduate proposal in Shell, et. al., Op. cit. in which all members of the cohort pay back over the same period. Here drop-outs begin and end their loan repayment period two years before the graduates.

Then if $T_i < T$ the payment required from ith the decile borrowers in their opt-out year, T_i , is:

$$P^i_{T_i} = (1+R)^{T_i+t}\left[B^*i - \sum_{\Theta=1}^{(T_i-1)} P^i_\Theta\, (1+R)^{-(\Theta+t)}\right] ,$$

and obviously $P^i_x = 0$ when $x > T_i$ (or $x > T$), since the loan is paid off. (See Appendix C for the cash-flow algorithm actually used in solving for the desired variables.)

In our computations, the breakeven interest rate (r) is set at 6%, the opt-out rate (R) is stipulated to be 8%, and we vary the length of the grace period (t), the expected growth rate of incomes after 1974 (g), and the possibilities of adverse self-selection under several scenarios. Table II enumerates seven possible participation scenarios, ranging from 100% in all deciles, to partial participation by only the lower five deciles. We do not expect much adverse selection, but anything can happen, as critics of such plans suggest (cf. Nerlove [8] and Hartman [5]). Further, adverse selection may be "unanticipated." We recognize this possibility and test the strength of the programs to these very extreme scenarios, using the rate of return as a criterion. Testing for "unanticipated" adverse self-selection is done only for the partially contingent program. We may infer, however, from our exercises with "anticipated" adverse selection with the fully contingent plan, that the rate of return will behave analogously to that in the exercises in Shell [10]; the two plans are not dissimilar.

Table II

Adverse Self-Selection Scenarios

Scenario No.	% Decile participating in the program									
	Decile									
	1	2	3	4	5	6	7	8	9	10
1	100	100	100	100	100	100	100	100	100	100
2	100	95	90	85	80	75	70	65	60	55
3	100	90	80	70	60	50	40	30	20	10
4	100	90	80	70	55	45	30	15	0	0
5	100	90	80	70	45	30	15	0	0	0
6	100	90	80	60	40	20	0	0	0	0
7	100	80	60	40	10	0	0	0	0	0

Our income data are more limited in scope than we would like (see Appendix A for derivation of income data). They do not indicate precisely at what age the largest jump in income occurs; however, in 1959, for MD's thirteen years after graduation, mean income was of the order 2.6 times that of those physicians out of school three years. (See Appendix Table A-1). Thus, allowing repayment to begin five years after graduation yields about a 20% drop in the magnitude of the tax rates required to enable the Bank to break even, cet.par.

The computational results in Table III for the fully contingent program emphasize the high returns to medical education as well as the relative stability to adverse selection of this variant. A physician entering medical school in 1974 would, if required to pay his loan back over twenty years starting one year from graduation day, pay Ed-Op repayment taxes at the rate of τ = .17% per $1,000 borrowed. (See Part 3, Table III.) If T = 30 years, τ drops to .10%, as compared with a .59% rate for the same undergraduate cohort, with similar assumptions (Shell, et. al., Table IV.15, p. 25). As mentioned above, the postponement of the repayment period's initial year substantially reduces the tax rate. For example, for T = 20, boosting t to 4 drops τ by 20% (.167% versus .132%), and when T = 30, τ drops by 11% (.100% versus .089%).

Given these parameters, the program is so attractive that only the top three deciles opt-out prior to the normal terminal year, T. Table IV presents the opt-out years (relative to T) for each of the four scenarios above, plus those for T = 25 years. The opt-out year for the 10th decile for t = 0, T = 20, occurs half-way through the repayment period, a fact which depends explicitly on the high average income we assume for that decile relative to the others, since given the assumed Pareto distribution, the top five percent of physicians earn nearly 50% more than the top 15 percent on the average (see Table A-4 in Appendix A). Hence, we expect that these physicians would be breaking even on their investment in medical education, even at 8%, in a short time period.

As can be seen from Part 4 of Table III, boosting the required rate of return to the bank to 8% and the opt-out rate commensurately to 10% raises the repayment tax rate, τ , by slightly more than the same percentage amount; i.e., the elasticity of τ with respect to the r , setting R by R-r = 2%, is greater than one and positive. Using the midpoint ARC elasticity:

$$\left(\frac{E\tau}{Er}\right)_{R-r=2\%} = \left[\frac{(r_1+r_2)/2}{(\tau_1+\tau_2)/2}\right]\left[\frac{\Delta\tau}{\Delta r}\right] = \left(\frac{r_1+r_2}{\tau_1+\tau_2}\right)\left(\frac{\tau_2-\tau_1}{r_2-r_1}\right)$$

This is because, with the higher opt-out rate, R , rich MD's cannot opt-out so quickly, thus accruing more interest to pay off in the form of a higher per-year (higher τ) payment, while delay of the opt-out dates through increasing pre-opt-out mortality shifts a greater burden of repayment onto the survivors.

Figure I depicts the relationship between r and τ , when R = 8%. The opt-out rate is an asymptote for $r = f(\tau)$, and of course, as $\tau \to 0$, $r \to -\infty$.

The cash flow outlined in Table V (D) shows the total repayment stream $\left(\sum_{i=1}^{10} \sum_{X=1}^{25} P_X^i\right)$* for all borrowers participating in a fully contingent program with parameters similar to those of the semi-conventional plan represented in Table I (d): t = 4, T = 25, r = 6%. The total repayments in this fully contingent program are larger than those of the comparable semi-conventional scheme in years 1984-1996, but drop off

* See Page 11 for explanation of P_X^i notation.

Figure I

Fully Contingent Program: Rate of Return, r, as a Function Tax Rate, τ, for the Fully Contingent Program with:

Opt-out Rate, R, = 8%
Grace Period, t = 0 years
Repayment Period, T = 25 years

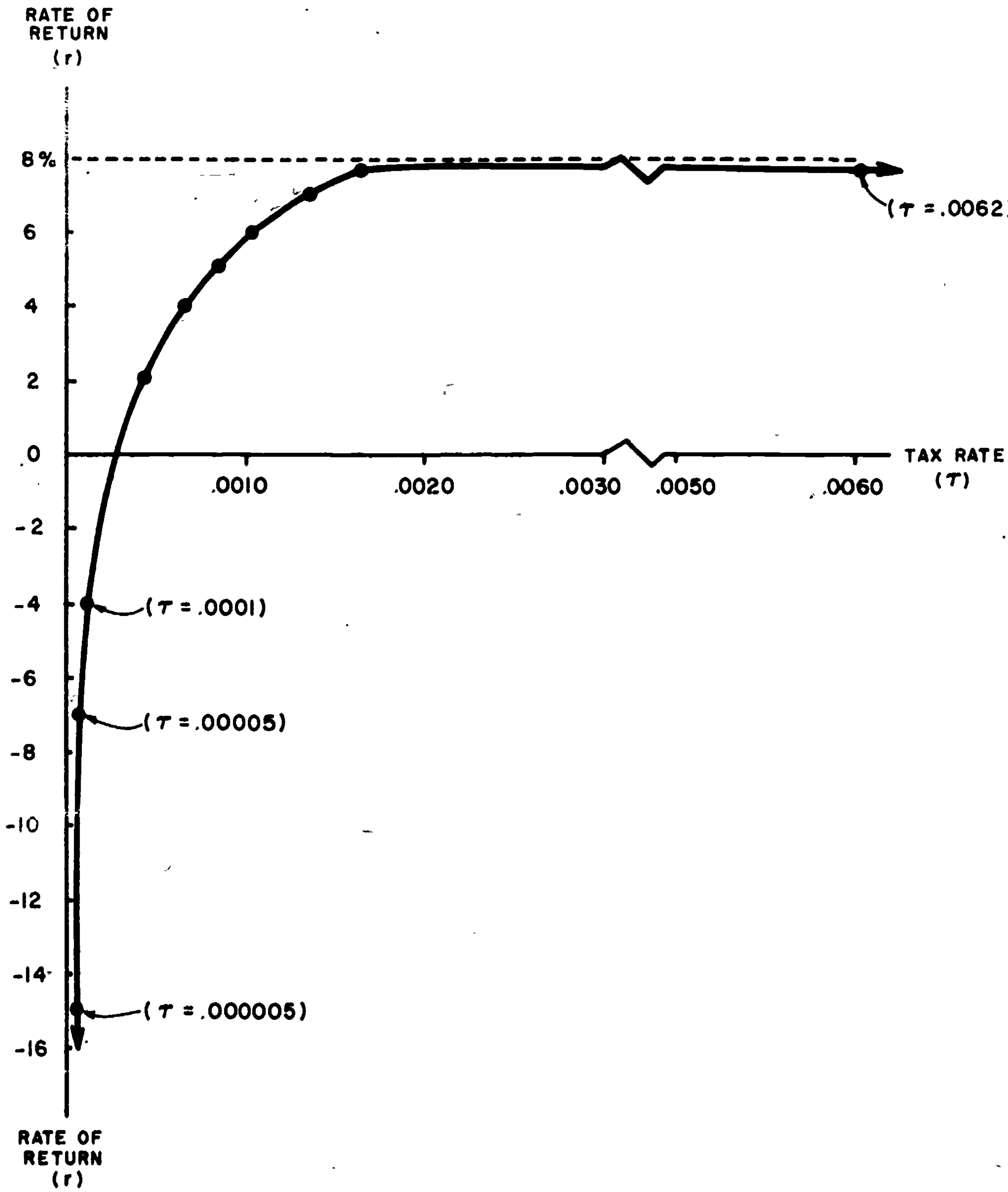

TABLE III

Fully Contingent Program:

Repayment tax rate, per thousand dollars borrowed, when the rate of return (r) = 6%, the opt-out rate (R) = 8%, repayments begin t years (varied) after graduation, and the repayment period (T) = 25 years, and g is the assumed rate of growth of physicians' incomes after 1974, for a class entering in 1974.

1. t = 0 (no grace period): τ (per cent/$1,000 borrowed)

Adverse self-selection Scenario No.	g = 5%	g = 4%	g = 3%	g = 2%
1*	.1223%	.1461%	.1741%	.2041%
2	.1269	.1513	.1803	.2144
3	.1347	.1604	.1905	.2258
4	.1388	.1650	.1957	.2317
5	.1422	.1690	.2003	.2368
6	.1443	.1714	.2031	.2399
7	.1464	.1735	.2051	.2416

2. t = 4 (4 year grace period)

Scenario No.	g = 5%	g = 4%	g = 3%	g = 2%
1*	.1045%	.1276%	.1552%	.1884%
2	.1093	.1331	.1617	.1958
3	.1167	.1417	.1717	.2073
4	.1208	.1466	.1774	.2139
5	.1240	.1504	.1818	.2190
6	.1259	.1525	.1842	.2217
7	.1270	.1545	.1862	.2234

* Scenario #1 represents full participation - no adverse self-selection.

3. τ for varying (t,T) with no adverse self-selection and g=5% (r=6%, R=8%)

T	t	τ
20	0	.1673%
20	4	.1323
30	0	.1000
30	4	.0889

4. τ for varying (t,T) with no adverse self-selection and g=5% (r=8%, R=10%)

T	t	τ
20	0	.2259%
20	4	.1864
25	0	.1723
25	4	.1537
30	0	.1457
30	4	.1357

TABLE IV

Fully Contingent Program:

Opt-out years by income decile, expressed as years after the repayment period begins.

Program	Decile 8th	9th	10th
t=0, T=20	19	17	11
t=4, T=20	*	18	12
t=0, T=25	*	21	14
t=4, T=25	*	18	15
t=0, T=30	*	26	22
t=4, T=30	*	29	18

*Eighth decile does not repay principal plus eight per cent interest in less than T years.

Parameters correspond to those in Table III, Part 3 (r=6%, R=8%, g=5%, no adverse selection).

TABLE V-A

FULLY CONTINGENT PROGRAM

OPT-OUT RATE = 8.00 % = R
REQUIRED RATE OF RETURN = 6.00 %
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.001045500 = τ

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	24999.99	0.0	26499.99	1500.00	-1500.00	-26499.99
1975	24999.99	0.0	54589.98	3090.00	-3090.00	-28089.99
1976	22750.00	0.0	81990.31	4640.39	-4640.39	-27390.39
1977	22750.00	0.0	111114.06	6283.81	-6283.81	-29033.81
1978	0.0	0.0	117674.88	6660.94	-6660.94	-6660.94
1979	0.0	0.0	124735.31	7060.49	-7060.49	-7060.49
1980	0.0	64.28	132155.13	7484.12	-7419.84	-7419.84
1981	0.0	69.83	140015.56	7929.31	-7860.48	-7860.48
1982	0.0	3369.09	145047.38	8400.94	-5031.85	-5031.85
1983	0.0	4145.90	149604.31	8702.85	-4556.96	-4556.96
1984	0.0	4990.65	153590.88	8976.27	-3986.62	-3986.62
1985	0.0	5904.97	156901.31	9215.46	-3310.50	-3310.50
1986	0.0	6894.38	159421.00	9414.09	-2519.71	-2519.71
1987	0.0	7964.75	161021.50	9565.28	-1600.52	-1600.52
1988	0.0	9121.58	161561.19	9661.31	-539.73	-539.73
1989	0.0	10370.63	160884.19	9693.69	676.94	676.94
1990	0.0	11718.92	158819.13	9653.90	2065.02	2065.02
1991	0.0	13156.73	155191.56	9529.17	3627.56	3627.56
1992	0.0	13867.95	150635.13	9311.52	4556.43	4556.43
1993	0.0	14616.75	145056.50	9038.13	5578.62	5578.62
1994	0.0	15405.13	138354.75	8703.41	6701.72	6701.72
1995	0.0	16235.06	130421.00	8301.31	7933.75	7933.75
1996	0.0	15965.88	122290.39	7825.29	8140.59	8140.59
1997	0.0	14575.64	115041.56	7336.86	7238.78	7238.78
1998	0.0	15323.86	106620.19	6902.53	8421.33	8421.33
1999	0.0	16109.36	96908.06	6397.25	9712.12	9712.12
2000	0.0	16934.11	85798.44	5814.52	11119.59	11119.59
2001	0.0	17745.85	73189.88	5147.34	12598.51	12598.51
2002	0.0	18155.76	59425.55	4391.43	13764.32	13764.32
2003	0.0	18568.05	44423.08	3565.58	15002.47	15002.47
2004	0.0	17625.14	29462.37	2665.43	14960.71	14960.71
2005	0.0	15943.66	15286.50	1767.79	14175.88	14175.88
2006	0.0	16195.74	8.00	917.23	15278.50	15278.50

OPT-OUT YEARS (BY DECILE OF MOIS , STARTING WITH THE LOWEST) : 25-25-25-25-25-25-25-25-23-15-.

OPT-OUT YEARS (FOR DROPOUTS) : 25

TABLE V-B

FULLY CONTINGENT PROGRAM

OPT-OUT RATE = 8.00 % = R
REQUIRED RATE OF RETURN = 6.00 %
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.001045500 = τ

DECILE # 1

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	2500.00	0.0	2650.00	150.00	-150.00	-2650.00
1975	2500.00	0.0	5458.99	309.00	-309.00	-2809.00
1976	2275.00	0.0	8198.03	464.04	-464.04	-2739.04
1977	2275.00	0.0	11101.42	628.39	-628.39	-2903.39
1978	0.0	0.0	11767.48	666.08	-666.08	-666.08
1979	0.0	0.0	12473.53	706.05	-706.05	-706.05
1980	0.0	6.43	13215.51	748.41	-741.99	-741.99
1981	0.0	6.88	14001.56	792.93	-786.05	-786.05
1982	0.0	174.53	14667.12	840.10	-665.57	-665.57
1983	0.0	232.97	15314.19	880.03	-647.05	-647.05
1984	0.0	296.63	15936.40	918.85	-622.22	-622.22
1985	0.0	365.87	16526.71	956.18	-590.31	-590.31
1986	0.0	440.94	17077.37	991.60	-550.66	-550.66
1987	0.0	522.33	17579.67	1024.64	-502.31	-502.31
1988	0.0	610.49	18023.96	1054.78	-444.29	-444.29
1989	0.0	705.87	18399.53	1081.44	-375.57	-375.57
1990	0.0	808.96	18694.54	1103.97	-295.01	-295.01
1991	0.0	919.30	18896.90	1121.67	-202.37	-202.37
1992	0.0	967.77	19062.95	1133.81	-166.05	-166.05
1993	0.0	1018.73	19187.99	1143.78	-125.05	-125.05
1994	0.0	1072.33	19266.94	1151.28	-79.95	-79.95
1995	0.0	1128.71	19294.24	1156.02	-27.30	-27.30
1996	0.0	1185.86	19266.04	1157.65	28.20	28.20
1997	0.0	1245.81	19176.19	1155.96	89.85	89.85
1998	0.0	1309.73	19018.02	1150.57	159.16	159.16
1999	0.0	1374.75	18784.35	1141.08	233.67	233.67
2000	0.0	1444.01	18467.40	1127.06	316.95	316.95
2001	0.0	1512.09	18063.35	1108.04	404.05	404.05
2002	0.0	1540.95	17606.20	1083.80	457.15	457.15
2003	0.0	1569.52	17093.05	1056.37	513.15	513.15
2004	0.0	1597.72	16520.91	1025.58	572.14	572.14
2005	0.0	1606.20	15905.96	991.25	614.95	614.95
2006	0.0	1626.01	15234.30	954.36	671.65	671.65

TABLE V-C

FULLY CONTINGENT PROGRAM

OPT-OUT RATE = 8.00 % = R
REQUIRED RATE OF RETURN = 6.00 %
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.001045500 = τ

DECILE # 5

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	2500.00	0.0	2650.00	150.00	-150.00	-2650.00
1975	2500.00	0.0	5458.00	309.00	-309.00	-2809.00
1976	2275.00	0.0	8198.03	464.04	-464.04	-2730.04
1977	2275.00	0.0	11101.42	628.38	-628.38	-2903.38
1978	0.0	0.0	11767.49	666.08	-666.08	-666.08
1979	0.0	0.0	12473.53	706.05	-706.05	-706.05
1980	0.0	6.43	13215.51	748.41	-741.98	-741.98
1981	0.0	6.88	14001.56	792.93	-786.05	-786.05
1982	0.0	234.00	14607.56	840.30	-606.30	-606.30
1983	0.0	302.65	15181.36	876.45	-573.80	-573.80
1984	0.0	377.30	15714.95	910.88	-533.58	-533.58
1985	0.0	458.40	16199.45	942.90	-484.50	-484.50
1986	0.0	546.25	16625.17	971.97	-425.72	-425.72
1987	0.0	641.44	16981.24	997.51	-356.08	-356.08
1988	0.0	744.45	17255.66	1018.88	-274.42	-274.42
1989	0.0	855.85	17435.14	1035.34	-179.49	-179.49
1990	0.0	976.18	17505.07	1046.11	-69.93	-69.93
1991	0.0	1104.88	17450.50	1050.30	54.57	54.57
1992	0.0	1163.78	17333.75	1047.03	116.75	116.75
1993	0.0	1225.76	17148.01	1040.03	185.73	185.73
1994	0.0	1290.98	16885.91	1028.88	262.10	262.10
1995	0.0	1359.61	16539.45	1013.16	346.46	346.46
1996	0.0	1429.21	16102.61	992.37	436.84	436.84
1997	0.0	1502.28	15566.48	966.16	536.13	536.13
1998	0.0	1578.99	14921.47	933.99	645.00	645.00
1999	0.0	1659.52	14157.24	895.29	764.23	764.23
2000	0.0	1744.04	13262.63	849.44	894.61	894.61
2001	0.0	1827.19	12231.20	795.76	1031.43	1031.43
2002	0.0	1866.77	11098.30	733.87	1132.90	1132.90
2003	0.0	1906.37	9857.83	665.90	1240.47	1240.47
2004	0.0	1945.94	8503.36	591.47	1354.47	1354.47
2005	0.0	1965.13	7047.43	510.20	1455.93	1455.93
2006	0.0	1996.40	5473.88	427.85	1573.55	1573.55

TABLE V-D

FULLY CONTINGENT PROGRAM

OPT-OUT RATE = 8.00 % = R
REQUIRED RATE OF RETURN = 6.00 %
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.001045500 = τ

DECILE # 10

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	2500.00	0.0	2650.00	150.00	-150.00	-2650.00
1975	2500.00	0.0	5453.09	300.00	-300.00	-2800.00
1976	2275.00	0.0	9198.03	464.04	-464.04	-2739.04
1977	2275.00	0.0	11101.40	628.38	-628.38	-2903.38
1978	0.0	0.0	11767.48	666.08	-666.08	-665.09
1979	0.0	0.0	12473.53	706.05	-706.05	-706.05
1980	0.0	6.43	13215.51	748.41	-741.98	-741.98
1981	0.0	6.88	14001.56	792.93	-786.05	-786.05
1982	0.0	922.58	13919.07	840.09	82.49	82.48
1983	0.0	1048.35	13705.87	835.15	213.21	213.21
1984	0.0	1184.08	13344.14	822.35	361.73	361.73
1985	0.0	1330.45	12814.33	800.65	529.80	529.80
1986	0.0	1487.63	12095.56	768.86	718.77	718.77
1987	0.0	1656.78	11164.51	725.73	931.05	931.05
1988	0.0	1838.69	9995.69	669.87	1168.82	1169.82
1989	0.0	2034.18	8561.25	599.74	1434.44	1434.44
1990	0.0	2244.14	6830.79	513.68	1730.46	1730.46
1991	0.0	2466.92	4773.71	409.85	2057.07	2057.07
1992	0.0	2604.89	2455.25	286.42	2318.46	2318.46
1993	0.0	2750.35	-147.79	147.32	2603.03	2603.03
1994	0.0	2903.67	-3060.32	-8.86	2912.54	2912.54
1995	0.0	3065.29	-6309.23	-183.62	3248.90	3248.90
1996	0.0	2118.01	-8805.79	-378.55	2496.57	2496.57
1997	0.0	15.72	-9349.86	-528.34	544.07	544.07
1998	0.0	16.24	-9927.08	-560.99	577.23	577.22
1999	0.0	16.78	-10539.48	-595.62	612.40	612.40
2000	0.0	17.33	-11189.18	-632.37	649.70	649.70
2001	0.0	17.84	-11879.37	-671.35	689.19	689.19
2002	0.0	18.19	-12609.26	-712.70	730.89	730.89
2003	0.0	18.55	-13384.36	-756.55	775.10	775.10
2004	0.0	18.90	-14206.32	-803.06	821.96	821.96
2005	0.0	0.0	-15058.70	-852.38	852.38	852.38
2006	0.0	0.0	-15962.21	-903.52	903.52	903.52

sharply in 1997 and then again in 2005. This may be explained by noting the exercise of the opt-out feature by deciles nine and ten (decile ten opts-out in 1996, 15 years after his initial payment; decile five opts-out in 2004, 23 years after his initial payment.) Looking to Tables II (b), (c) and (d), one sees how the incidence of the repayment burden is distributed over three representative deciles:
one, five and ten. The largest difference, of course, is between deciles five and ten, as the highest-income graduates make relatively large repayments until their opt-out year, 1996. The last four payments made by this decile ten borrower represent his subsidization of deciles one through nine (note that he had almost repaid his loan, at 6%, in 1992.) This pattern holds over all of our sample fully-contingent repayment schemes: High payments by the upper two or three deciles serve to reduce the debt rapidly in the early years of the cohort repayment period and thus lessen interest accrual and the repayment burden of the lower income deciles.

C. Partially Contingent Plan

To describe the partially contingent variant we add a new parameter to and delete an old one from the parameters of the fully contingent scheme. The coupon rate (the new parameter), r_c, is the interest rate implied by the coupon repayment schedule which constitutes one of the two options available to the MD each year. To determine r_c, and thus the payments schedule, (which grows at γ per cent per annum, as in the semi-conventional variant), we must set T, the length of time over which all borrowers are obligated to make repayments, τ, the repayment tax rate per $1,000 borrowed, and t, the grace period, and we must make an assumption about g, the rate of growth of MD's incomes. The coupon payment option replaces the opt-out feature, and R is therefore not included in the parameter list of the partially contingent scheme. If we specify a rate of return, r, and all other parameters except τ and r_c, we may solve equally well for either τ or r_c, given the other. In practice, we set τ and solve for r_c, so that we may retain τ's which are comparable to those tested in the fully contingent variant.

Perhaps the borrowing MD's repayment choice may best be illustrated by presentation of the following specimen form letter, Figure II, which might be sent as his annual bill.

As mentioned above, P_t^i, the payment made by a doctor in the ith income decile in year t following graduation, is min $(\tau Y_t^i, C_t)$, per thousand dollars borrowed. Borrowings, $\tilde{B}^i$, inclusive of accumulated interest during medical school remain the same as above; i.e.

$$\tilde{B}^i = 250\ B^i\ [\sum_{j=1}^{4}(1 + r_c)^j]$$

Note that here, r_c is used to compute interest accumulated, whereas under the fully contingent scheme, the opt-out rate, R, is used to determine B^{*i} and thus T_i. Given a feasible (τ, r_c) combination it will always be true that the present value of the coupon schedules repayment stream at the time of graduation will be greater than or equal to the outstanding debt at that time:

$$\sum_i B^{*i} \leq \sum_{\theta=1}^{T} \quad (1+r_c)^{-(\theta+t)}(1 + \gamma)^{\theta} C_0\ ,$$

where C_0 is the payment in the initial year. Now, $C_t = C_0(1 + \gamma)^t$. Note also that this inequality becomes an equality if, and only if, τ is sufficiently high so that the contingency option is never exercised and there is no mortality during the period.

FIGURE II

UPSTATE UNIVERSITY

Medical Education Opportunity Bank

College Town California 94302

April 15, 1979

Dr. John Q. Borrower
Smalltown Hospital
Smalltown, New York 10708

Dear Dr. Borrower:

In 1974 you borrowed $x thousand for your medical education to be repaid over a 30-year period. As you know, each year you are given the choice of meeting your repayment obligation with a coupon, which this year is $Y, or with a tax repayment, for which the tax rate is 0.Z% (0.00Z) from your current adjusted gross income, whichever is less. The coupon payment is Y% higher than last year, reflecting your increased ability to pay as your income grows.

Your payment is due within thirty (30) days of the date on this letter. Please transfer funds electronically if possible, to our account number xxxyyy-zzz. If you choose the tax payment, code your social security number with the payment and attach a certified "true copy" of the form 1040 you submitted with your Federal Income tax.

Sincerely,

Joseph H. President
Medical Educational
Opportunity Bank

JHP/ecc

Similarly, a feasible (τ, r_c) combination will insure the validity of the following inequality, where P_θ^k represents the repayments by all individuals belonging to the set K in year θ of their repayment period.

$$\left[\sum_{j=1}^{4} L_j \left\{\sum_i n_1^i (1+r)^j\right\}\right] \leq \sum_{\theta=1}^{T} (1+r)^{-(\theta+t)}\left[\sum_{k\in D} n_\theta^k P_\theta^k + \frac{1}{2}\sum_{k\in D} n_\theta^k P_\theta^k\right]$$

where L_j is the loan extended in year j , $i\in G$, D* if $j \leq 2$, $i\in G$ otherwise and n_y^i is the number of persons in the ith decile in year $\frac{x}{y}$. Now, since $P_\theta^k = \tau Y_\theta^k$, if we hold τ fixed, we may determine C_0 from the above, and hence r_c. This constitutes the relationship between r_c and τ: given r and τ, the payments min $(\tau Y_t^i , C_t)$ must be sufficient to reduce outstanding debt to zero in T years.

Results from the partially contingent program are presented in Tables VI - IX and Figures III and IV. In Table VI, we explore r = 6% with τ = .26%. This yields a "coupon rate," r_c , which becomes increasingly close to the rate of return, r, as the grace period, t, is extended. This is because MDs' incomes grow very quickly in the first four years, so fewer chose the τY_t option when the grace period was available. In general, for both r = 6% and r = 8%, it was felt that the τY_t option was elected too frequently (to realize our goal of minimizing administrative costs) in schemes with a short or no grace period, since even the higher income MD's exercise the option. A τ of .33% seems to give a somewhat "attractive" pattern in the r = 8% program; except for low or zero t, there is not much change.

(Attractive has the meaning of the above discussion with reference to

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* G means graduates, and D means dropouts.

Figure III

Partially Contingent Program with: ISO - r LOCI

Grace Period, t = 4
Repayment Period, T = 25
Income Growth, g = 5%

No Adverse Selection
(scenario = 1)
Growth of Coupon Payments
γ = 10%

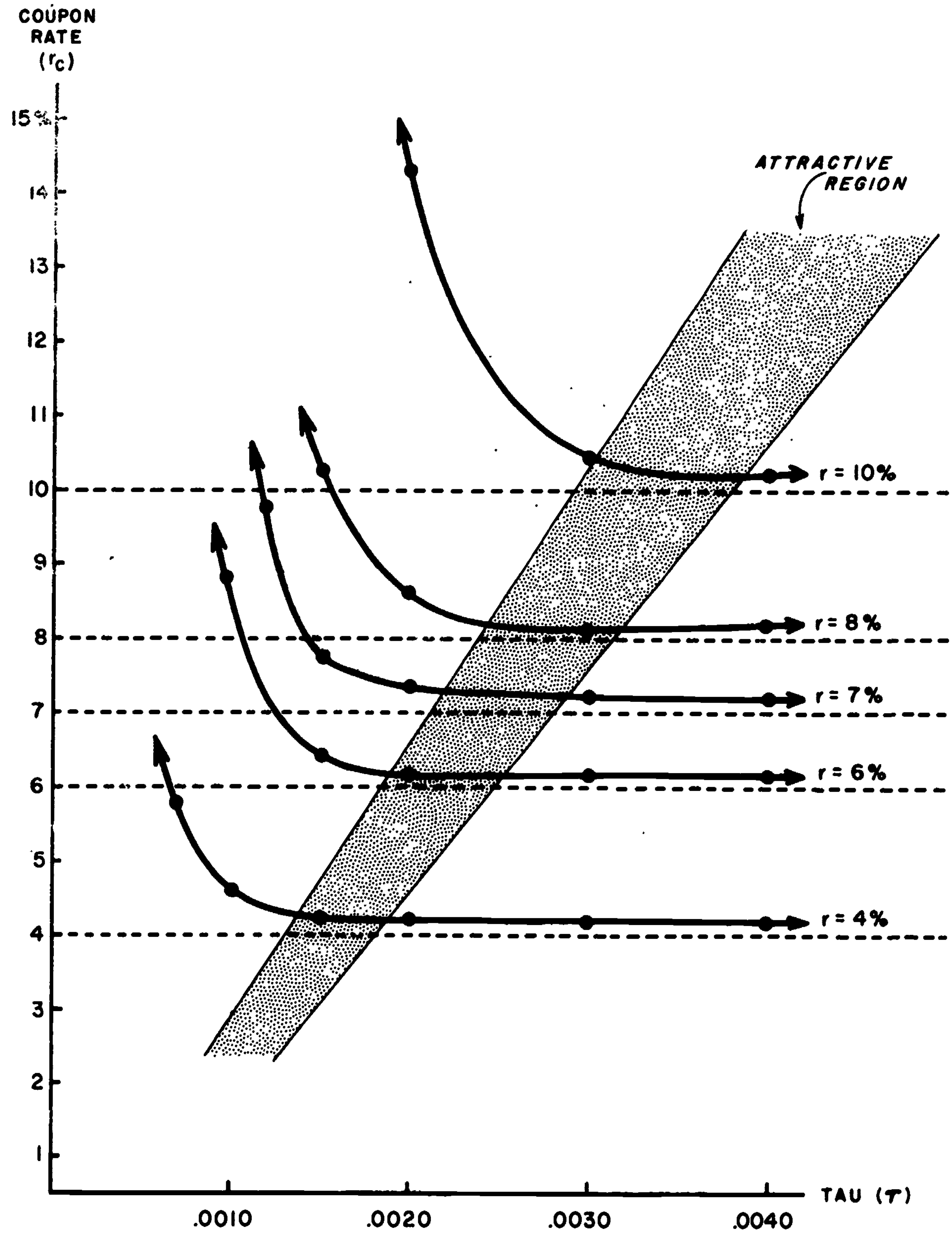


Figure IV

Partially Contingent Program: Anticipated Adverse Selection
Coupon Rate, r_c, required to maintain rate of return, r, at 6%
When Income Growth is Anticipated to be g, with:
Tax Rate, $\tau = .0020$
Repayment Period, T = 25 Years
Growth of Coupon Payments, γ, = 10%
For Various Anticipated Adverse Selection Scenarios
and Differing Lengths, t, of grace period

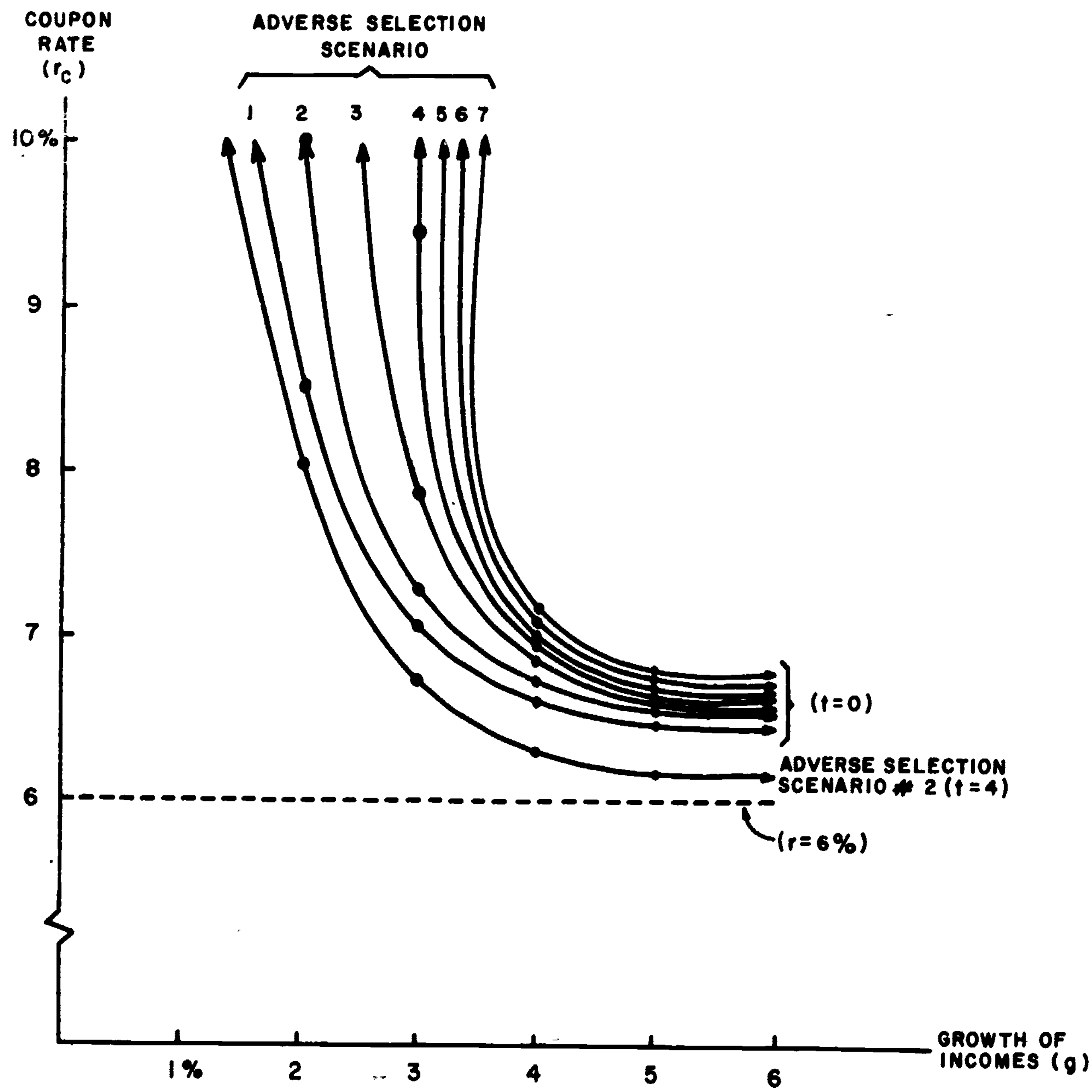


TABLE VI

Partially Contingent Program:

"Coupon rate," r_c, given τ, the repayment tax rate per thousand dollars borrowed; r, the rate of return; t, the grace period after which the repayment period begins; T, the repayment period = 25 years; g, income growth after 1974 = 5%; and λ, rate of growth of repayments for the coupon option = 10%.

1. $\tau = .26\%$, $r = 6\%$

t (grace period)	r_c	Contingency by Decile* 1	2	3	4	5	6	7	8	9	10
0	6.39%	5	5	4	4	3	3	2	1	-	-
1	6.25	4	3	3	3	2	2	1	-	-	-
2	6.17	2	2	2	1	1	1	-	-	-	-
3	6.14	1	1	1	-	-	-	-	-	-	-

2. $\tau = .26\%$, $r = 8\%$

t (grace period)	r_c	Contingency by Decile* 1	2	3	4	5	6	7	8	9	10
0	8.60%	7-1	6	6	6	5	4	4	2	-	-
1	8.48	6-1	5-1	5	4	4	3	2	1	-	-
2	8.34	4-2	4-1	4-1	3	3	2	1	-	-	-
3	8.30	3-3	3-2	2-1	2-1	2	1	-	-	-	-

3. $t = .33\%$, $r = 8\%$

t (grace period)	r_c	Contingency by Decile* 1	2	3	4	5	6	7	8	9	10
0	8.44%	5	5	5	4	4	3	3	2	-	-
1	8.34	4	4	3	3	3	2	1	-	-	-
2	8.23	3	3	2	2	2	1	-	-	-	-
3	8.18	2	2	1	1	-	-	-	-	-	-
4	8.16	1	-	-	-	-	-	-	-	-	-

4. $\tau = .40\%$, $r = 8\%$

t (grace period)	r_c	Contingency by Decile* 1	2	3	4	5	6	7	8	9	10
0	8.35%	4	4	4	3	3	3	2	1	-	-
1	8.26	3	3	3	2	2	1	1	-	-	-
2	8.16	2	2	2	1	1	-	-	-	-	-

*The notation used here indicates the number of years for which physicians in each decile exercise the τY_t, or contingency, option. A single number, e.g., 6, indicates that the option was exercised during the first six years of the repayment period. Two numbers separated by a dash, say 5-1, denote exercising of the option in both the beginning five (5) years and the ending (1) years of the repayment period.

TABLE VII-A

PARTIALLY CONTINGENT PROGRAM

FIXED REPAYMENTS GROW AT 10.00% = Y
FROM STARTING PAYMENT OF $ 41.94
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.002000000
INTEREST RATE = 6.0000% = r

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	24999.99	0.0	26499.99	1500.00	-1500.00	-26499.99
1975	24999.99	0.0	54589.98	3000.00	-3000.00	-28089.99
1976	22750.00	0.0	81980.31	4640.39	-4640.39	-27390.39
1977	22750.00	0.0	111014.06	6283.81	-6283.81	-29033.81
1978	0.0	0.0	117674.89	6660.84	-6660.84	-6660.84
1979	0.0	0.0	124735.31	7060.49	-7060.49	-7060.49
1980	0.0	122.97	132096.44	7484.12	-7361.15	-7361.15
1981	0.0	131.67	139890.59	7925.79	-7794.12	-7794.12
1982	0.0	3804.05	144470.88	8323.43	-4590.38	-4590.38
1983	0.0	4290.26	148959.28	8668.30	-4379.54	-4379.54
1984	0.0	4706.32	153083.56	8931.51	-4225.19	-4225.19
1985	0.0	5162.70	157105.88	9185.02	-4022.33	-4022.33
1986	0.0	5661.32	160870.88	9426.36	-3765.05	-3765.05
1987	0.0	6208.06	164315.06	9652.27	-3444.20	-3444.20
1988	0.0	6807.63	167366.31	9859.02	-3051.39	-3051.29
1989	0.0	7465.10	169943.19	10041.99	-2576.89	-2576.89
1990	0.0	8186.12	171953.63	10196.61	-2010.48	-2010.48
1991	0.0	8967.51	173303.31	10317.23	-1349.72	-1349.72
1992	0.0	9817.75	173893.75	10398.21	-580.46	-580.46
1993	0.0	10749.38	173567.39	10433.64	316.24	316.24
1994	0.0	11770.25	172211.13	10414.05	1356.19	1356.19
1995	0.0	12888.88	169654.88	10332.68	2556.20	2556.20
1996	0.0	14089.94	165745.13	10179.30	3910.73	3910.73
1997	0.0	15401.57	160289.25	9944.72	5456.85	5456.85
1998	0.0	16837.04	153069.50	9617.31	7219.73	7219.73
1999	0.0	18406.02	143845.69	9184.12	9222.80	9222.80
2000	0.0	20123.79	132352.63	8630.75	11493.04	11493.04
2001	0.0	21934.57	118359.19	7941.18	13993.39	13993.39
2002	0.0	23904.45	101556.25	7101.57	16802.88	16802.88
2003	0.0	26051.13	81598.50	6093.39	19957.74	19957.74
2004	0.0	28390.32	59194.12	4895.03	23494.38	23494.38
2005	0.0	30570.55	31019.84	3486.27	27084.27	27084.27
2006	0.0	32910.38	-29.32	1861.22	31049.16	31049.16

TABLE VII-B

PARTIALLY CONTINGENT PROGRAM

FIXED REPAYMENTS GROW AT 10.00% = Y
FROM STARTING PAYMENT OF $ 41.94
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.002000000
INTEREST RATE = 6.0000% = r

DECILE # 1

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	2500.00	0.0	2650.00	150.00	-150.00	-2650.00
1975	2500.00	0.0	5458.99	309.00	-309.00	-2809.00
1976	2275.00	0.0	8198.03	464.04	-464.04	-2739.04
1977	2275.00	0.0	11101.40	628.38	-628.39	-2903.38
1978	0.0	0.0	11767.48	666.08	-666.08	-666.08
1979	0.0	0.0	12473.53	706.05	-706.05	-706.05
1980	0.0	12.30 #	13209.64	748.41	-736.11	-736.11
1981	0.0	13.17 #	13989.05	792.58	-779.41	-779.41
1982	0.0	333.97 ● #	14494.53	839.34	-505.48	-505.48
1983	0.0	429.93 #	14935.18	869.67	-440.65	-440.65
1984	0.0	470.63 #	15360.65	896.11	-425.48	-425.48
1985	0.0	516.27 #	15766.02	921.64	-405.37	-405.37
1986	0.0	566.13 #	16145.85	945.96	-379.83	-379.83
1987	0.0	620.81 #	16493.79	968.75	-347.94	-347.94
1988	0.0	680.76 #	16802.65	989.62	-309.86	-309.86
1989	0.0	746.51 #	17064.39	1009.16	-261.65	-261.65
1990	0.0	818.61 #	17269.54	1023.86	-205.24	-205.24
1991	0.0	896.75 #	17408.96	1036.17	-139.42	-139.42
1992	0.0	981.78 #	17471.72	1044.54	-62.76	-62.76
1993	0.0	1074.94 #	17445.08	1048.30	26.64	26.64
1994	0.0	1177.03 #	17314.76	1046.71	130.32	130.32
1995	0.0	1289.89 #	17064.75	1038.89	250.01	250.01
1996	0.0	1403.91 #	16679.73	1023.89	385.02	385.02
1997	0.0	1540.16 #	16140.35	1000.78	539.38	539.38
1998	0.0	1683.71 #	15425.06	968.42	715.29	715.29
1999	0.0	1840.69 #	14509.87	925.50	915.19	915.19
2000	0.0	2012.38 #	13368.08	870.59	1141.79	1141.79
2001	0.0	2193.46 #	11976.70	802.09	1391.38	1391.38
2002	0.0	2390.45 #	10304.86	718.60	1671.84	1671.84
2003	0.0	2605.12 #	8319.03	618.29	1986.82	1986.82
2004	0.0	2839.03 #	5978.08	499.08	2339.95	2339.95
2005	0.0	3057.06	3279.71	358.69	2698.37	2698.37
2006	0.0	3110.50 ●	366.00	196.78	2913.71	2913.71

● IMPLIES CONTINGENCY OPTION EXERCISED BY GRADUATES
IMPLIES CONTINGENCY EXERCISED BY DROPOUTS

TABLE VII C

PARTIALLY CONTINGENT PROGRAM

FIXED REPAYMENTS GROW AT 10.00% = Y
FROM STARTING PAYMENT OF $ 41.04
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.002000000
INTEREST RATE = 6.0000% = r

DECILE # 5

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	2500.00	0.0	2650.00	150.00	-150.00	-2650.00
1975	2500.00	0.0	5459.00	309.00	-309.00	-2809.00
1976	2275.00	0.0	8198.03	464.04	-464.04	-2739.04
1977	2275.00	0.0	11101.40	628.38	-628.38	-2903.38
1978	0.0	0.0	11767.48	666.08	-666.08	-666.08
1979	0.0	0.0	12473.53	706.05	-706.05	-706.05
1980	0.0	12.30 #	13209.64	748.41	-736.11	-736.11
1981	0.0	13.17 #	13989.05	792.58	-779.41	-779.41
1982	0.0	391.09 #	14437.30	839.34	-448.25	-448.25
1983	0.0	429.03 #	14874.52	866.24	-437.21	-437.21
1984	0.0	470.63 #	15296.35	892.47	-421.84	-421.84
1985	0.0	516.27 #	15697.86	917.78	-401.51	-401.51
1986	0.0	566.13 #	16073.60	941.87	-375.74	-375.74
1987	0.0	620.81 #	16417.20	964.42	-343.61	-343.61
1988	0.0	690.76 #	16721.47	985.03	-304.27	-304.27
1989	0.0	746.51 #	16978.24	1003.29	-256.78	-256.78
1990	0.0	819.61 #	17179.32	1019.70	-200.08	-200.08
1991	0.0	896.75 #	17312.27	1030.70	-133.95	-133.95
1992	0.0	981.78 #	17369.22	1038.74	-56.96	-56.96
1993	0.0	1074.94 #	17336.43	1042.15	32.79	32.79
1994	0.0	1177.03 #	17199.59	1040.19	136.84	136.84
1995	0.0	1288.89 #	16942.67	1031.98	256.92	256.92
1996	0.0	1408.91 #	16550.32	1016.56	392.35	392.35
1997	0.0	1540.16 #	16003.18	993.02	547.14	547.14
1998	0.0	1683.71 #	15279.67	960.19	723.52	723.52
1999	0.0	1840.69 #	14355.75	916.78	923.91	923.91
2000	0.0	2012.38 #	13204.72	861.35	1151.03	1151.03
2001	0.0	2193.46 #	11893.54	792.28	1401.18	1401.18
2002	0.0	2390.45 #	10121.30	708.21	1682.23	1682.23
2003	0.0	2605.12 #	8123.46	607.28	1997.84	1997.84
2004	0.0	2839.03 #	5771.84	487.41	2351.63	2351.63
2005	0.0	3057.06	3061.09	346.31	2710.74	2710.74
2006	0.0	3319.67	-74.91	183.67	3136.00	3136.00

@ IMPLIES CONTINGENCY OPTION EXERCISED BY GRADUATES
# IMPLIES CONTINGENCY EXERCISED BY DROPOUTS

TABLE VII-D

PARTIALLY CONTINGENT PROGRAM

FIXED REPAYMENTS GROW AT 10.00% = Y
FROM STARTING PAYMENT OF $ 41.94
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.002000000
INTEREST RATE = 6.0000% = r

DECILE # 10

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	2500.00	0.0	2650.00	150.00	-150.00	-2650.00
1975	2500.00	0.0	5459.09	309.09	-309.09	-2809.09
1976	2275.00	0.0	8199.03	464.04	-464.04	-2739.04
1977	2275.00	0.0	11101.40	628.38	-628.38	-2903.38
1978	0.0	0.0	11767.48	666.08	-666.08	-666.08
1979	0.0	0.0	12473.53	706.05	-706.05	-706.05
1980	0.0	12.30 #	13209.64	748.41	-736.11	-736.11
1981	0.0	13.17 #	13989.05	792.58	-779.41	-779.41
1982	0.0	391.09 #	14437.30	839.34	-448.25	-448.25
1983	0.0	429.03 #	14374.52	866.24	-437.21	-437.21
1984	0.0	470.63 #	15296.35	892.47	-421.84	-421.84
1985	0.0	516.27 #	15697.86	917.78	-401.51	-401.51
1986	0.0	566.13 #	16273.60	941.87	-375.74	-375.74
1987	0.0	620.81 #	16417.20	964.42	-343.61	-343.61
1988	0.0	680.76 #	16721.47	985.03	-304.27	-304.27
1989	0.0	746.51 #	16978.24	1003.29	-256.78	-256.78
1990	0.0	818.61 #	17179.32	1018.70	-200.08	-200.08
1991	0.0	896.75 #	17312.27	1030.70	-133.95	-133.95
1992	0.0	981.78 #	17369.22	1038.74	-56.96	-56.96
1993	0.0	1074.94 #	17336.43	1042.15	32.79	32.79
1994	0.0	1177.03 #	17199.59	1040.19	136.84	136.84
1995	0.0	1288.89 #	16942.67	1031.98	256.92	256.92
1996	0.0	1409.91 #	16550.32	1016.56	392.35	392.35
1997	0.0	1541.16 #	16003.18	993.02	547.14	547.14
1998	0.0	1683.71 #	15279.67	960.19	723.52	723.52
1999	0.0	1840.69 #	14355.75	916.78	923.91	923.91
2000	0.0	2012.38 #	13204.72	861.35	1151.03	1151.03
2001	0.0	2193.46 #	11803.54	792.28	1401.18	1401.18
2002	0.0	2390.45 #	10121.30	708.21	1682.23	1682.23
2003	0.0	2605.12 #	8123.46	607.28	1997.84	1997.84
2004	0.0	2839.54 #	5771.84	487.41	2351.63	2351.63
2005	0.0	3057.06	3061.09	346.31	2710.74	2710.74
2006	0.0	3319.67	-74.91	183.67	3136.00	3136.00

@ IMPLIES CONTINGENCY OPTION EXERCISED BY GRADUATES
# IMPLIES CONTINGENCY EXERCISED BY DROPOUTS

TABLE VII-E

SEMI-CONVENTIONAL LOAN PROGRAM

FIXED REPAYMENTS GROW AT 10.00% = Y
FROM STARTING PAYMENT OF $ 41.94
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
INTEREST RATE = 6.1674% = r

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	24999.99	0.0	26541.83	1541.84	-1541.84	-26541.83
1975	24999.99	0.0	54720.59	3179.77	-3179.77	-28179.76
1976	22750.00	0.0	82249.44	4777.98	-4777.98	-27527.88
1977	22750.00	0.0	111474.00	6475.63	-6475.63	-29225.62
1978	0.0	0.0	118349.00	6875.00	-6875.00	-6875.00
1979	0.0	0.0	125649.00	7299.00	-7299.00	-7299.00
1980	0.0	187.09	133210.06	7749.16	-7562.07	-7562.07
1981	0.0	205.44	141227.13	8215.54	-8010.11	-8010.11
1982	0.0	3995.79	145933.94	8709.55	-4713.85	-4713.85
1983	0.0	4387.57	150546.63	9000.28	-4612.70	-4612.70
1984	0.0	4817.96	155013.50	9284.71	-4466.89	-4466.89
1985	0.0	5290.33	159233.38	9563.25	-4269.91	-4269.91
1986	0.0	5807.07	163200.88	9823.59	-4016.51	-4016.51
1987	0.0	6374.27	166906.88	10071.30	-3697.03	-3697.03
1988	0.0	6996.84	170209.21	10299.21	-3302.46	-3302.46
1989	0.0	7680.17	173122.06	10532.98	-2852.81	-2852.81
1990	0.0	8430.21	175369.89	10677.07	-2246.86	-2246.86
1991	0.0	9243.79	176940.69	10815.64	-1571.84	-1571.84
1992	0.0	10125.79	177717.44	10912.58	-776.79	-776.79
1993	0.0	11113.72	177564.19	10960.48	153.24	153.24
1994	0.0	12185.91	176329.25	10951.03	1234.88	1234.88
1995	0.0	13361.41	173942.69	10874.87	2486.55	2486.55
1996	0.0	14623.49	169949.69	10721.51	3901.98	3901.98
1997	0.0	16004.39	164417.13	10480.86	5523.52	5523.52
1998	0.0	17515.20	157042.13	10140.20	7375.00	7375.00
1999	0.0	19169.17	147559.31	9685.36	9482.88	9482.88
2000	0.0	20976.56	135583.25	9100.52	11876.04	11876.04
2001	0.0	22885.27	121166.00	8368.08	14517.10	14517.10
2002	0.0	24965.94	103672.91	7472.75	17493.18	17493.18
2003	0.0	27233.91	82932.75	6392.89	20840.02	20840.02
2004	0.0	29705.79	58235.57	5108.61	24597.18	24597.18
2005	0.0	30570.55	31256.64	3591.61	26978.93	26978.93
2006	0.0	33196.68	-12.31	1927.73	31268.95	31268.95

TABLE VIII

Partially Contingent Program:

"Anticipated" adverse self-selection: Solve for r_c, the coupon rate, given τ, the repayment tax rate = .20%; r, the rate of return = 6%; T, the repayment period = 25 years; λ, the rate of growth of coupon repayments = 10%; and varying t, the grace period, and g, the rate of growth of incomes after 1974.

1. t (grace period) = 0 years

Adverse selection Scenario No.	g = 5%	g = 4%	g = 3%	g = 2%
1	6.51%	6.60%	7.02%	8.50%
2	6.55	6.67	7.23	10.02
3	6.64	6.82	7.86	infeasible
4	6.69	6.92	9.47	
5	6.72	7.00	infeasible	
6	6.74	7.07		
7	6.78	7.20		

2. t = 4 years

Scenario No.	g = 5%	g = 4%	g = 3%	g = 2%
1	6.17%	6.27%	6.63%	7.56%
2	6.17	6.29	6.72	8.04
3	6.17	6.34	6.95	infeasible
4	6.17	6.37	7.11	
5	6.18	6.40	7.26	
6	6.18	6.42	7.38	
7	6.18	6.47	7.67	

Table IX

Partially Contingent Program:

"Unanticipated" adverse self-selection: solve for r, rate of return, given τ, repayment tax rate = .20%; T, repayment period = 25 years; γ, rate of growth of coupon repayments = 10%; r_c, coupon rate, from Scenario 1, Table V, and varying g, rate of growth of incomes, and t, the grace period.

1. t = 0 years

Scenario No.	g = 5% (r_c = 6.51%)	g = 4% (r_c = 6.6%)	g = 3% (r_c = 7.02%)	g = 2% (r_c = 8.5%)
1	6.00%	6.00%	6.00%	6.00%
2	5.96	5.95	5.89	5.74
3	5.90	5.85	5.69	5.26
4	5.86	5.80	5.57	4.96
5	5.83	5.75	5.48	4.78
6	5.81	5.73	5.42	4.67
7	5.79	5.68	5.32	4.49

2. t = 4 years

Scenario No.	g = 5% (r_c = 6.17%)	g = 4% (r_c = 6.27%)	g = 3% (r_c = 6.63%)	g = 2% (r_c = 7.56%)
1	6.00%	6.00%	6.00%	6.00%
2	6.00	5.98	5.94	5.85
3	6.00	5.95	5.82	5.56
4	5.99	5.92	5.75	5.39
5	5.99	5.90	5.69	5.28
6	5.99	5.89	5.66	5.21
7	5.99	5.86	5.59	5.01

the bank and administrative costs.) The sensitivity to changes in the grace period naturally reflects the low income of those early intern years in our data, as shown in Table A-5 of the Appendix. We conjecture, however, that interns are nowhere near as poor (relative to physicians' lifetime incomes) today as in 1960, and that therefore our $t = 4$ might yield a more realistic approximation to the same program run with, say, 1970 census data and a lower t. Most of the 1970 census data was published before this writing, but the publication presenting incomes by profession was not available to us.

Figure III presents iso - r loci in (r_c, τ) - space: for a given rate of return, the $\tau - r_c$ trade-off is illustrated. Each of these loci has two asymptotes - the coupon rate can never fall below r, and there exist positive τ's for each r such that r_c approaches infinity. Thus, the iso - r loci are convex to the origin in the positive quadrant of (τ, r_c) space. Infeasible r_c's occur at τ's somewhat <u>below</u> the break-even τ's from the fully contingent program, (cf. Table III) or southwest of each locus, which thus defines a feasibility frontier for the program, given r.

This frontier may be described more precisely by noting that, by design of the fully contingent and partially contingent variants, it will always be true that:

$$\lim_{r_c \to \infty} \tau_{pc} (\bar{r}, r_c) = \lim_{R \to \infty} \tau_{fc} (\bar{r}, R) .$$

This is so because for an equal rate-of-return in the two variants, the above limits imply that the income-contingent repayment will be made by all borrowers in each year of the repayment period (i.e., there will be no coupon payments in the partially contingent scheme and no opting-out in the fully contingent scheme). It will also be true that:

$$\lim_{r_c \to \infty} \tau_{pc}(\bar{r}, r_c) \leq \tau_{fc}(\bar{r}, R) \quad \text{for } \bar{r} < R < \infty ,$$

the inequality holding only for R sufficiently small that some opting-out occurs, thus requiring a larger τ than that of the comparable partially contingent scheme, where no opting-out is possible, and the coupon option is never exercised with r_c very large.

Tables VII (a)-(e) present the cash flow for a partially-contingent program which may be considered attractive for both the borrower and lender (relatively low tax rate and very little contingency exercise.) This may be verified by noting in Figure II the $\tau = .0020$ point on the $\bar{r} = 6\%$ locus. Higher tax rates do not significantly improve the low rate of contingency exercise, lower tax rates boost the required coupon rate rather quickly. For this reason, we have chosen this particular parameter combination to test the stability of the program to extreme adverse selection and income growth assumptions (see Tables VIII and IX, Figures IV and V).

If one compares these cash flows with those given to illustrate the semi-conventional and fully-contingent plans (see Table I (d) and Tables V (a)-(d)), it is very apparent that the partially-contingent plan's repayments are very close to those of the semi-conventional plan. This is consistent, of course, with the extremely low contingency exercise implied by this particular parameter combination. Looking to the decile cash flows, one sees that only in decile one do graduates take advantage of the contingency option ($\tau = .0020$), in the first and last years of his repayment period.

This partially contingent plan thus illustrates a loan contract which guarantees the borrower that he will pay no more than 6.17% interest (the coupon rate corresponding to the required starting payment of \$41.94 in the optimal fixed-repayment schedule - see Table VII (e)) over the twenty-five year repayment period. Indeed, he will pay less if in any year .20% of his income is less than the required coupon payment in that year (\$41.94 in year 1, (\$41.94) $(1.10)^{24}$ = \$454.63 in year 25). This gives income protection to potential low-earners, yet does not burden high-earners with the 8% opt-out interest rate of the fully contingent program. The cost of this compromise solution (between semi-conventional and fully-contingent plans) is two fold:

(1) slightly higher coupon payments than comparable semi-conventional plan (coupon rate = 6.17% rather than 6.00%)

(2) higher tax rate than comparable fully-contingent program ($\tau = .0020$ rather than $\tau = .00105$).

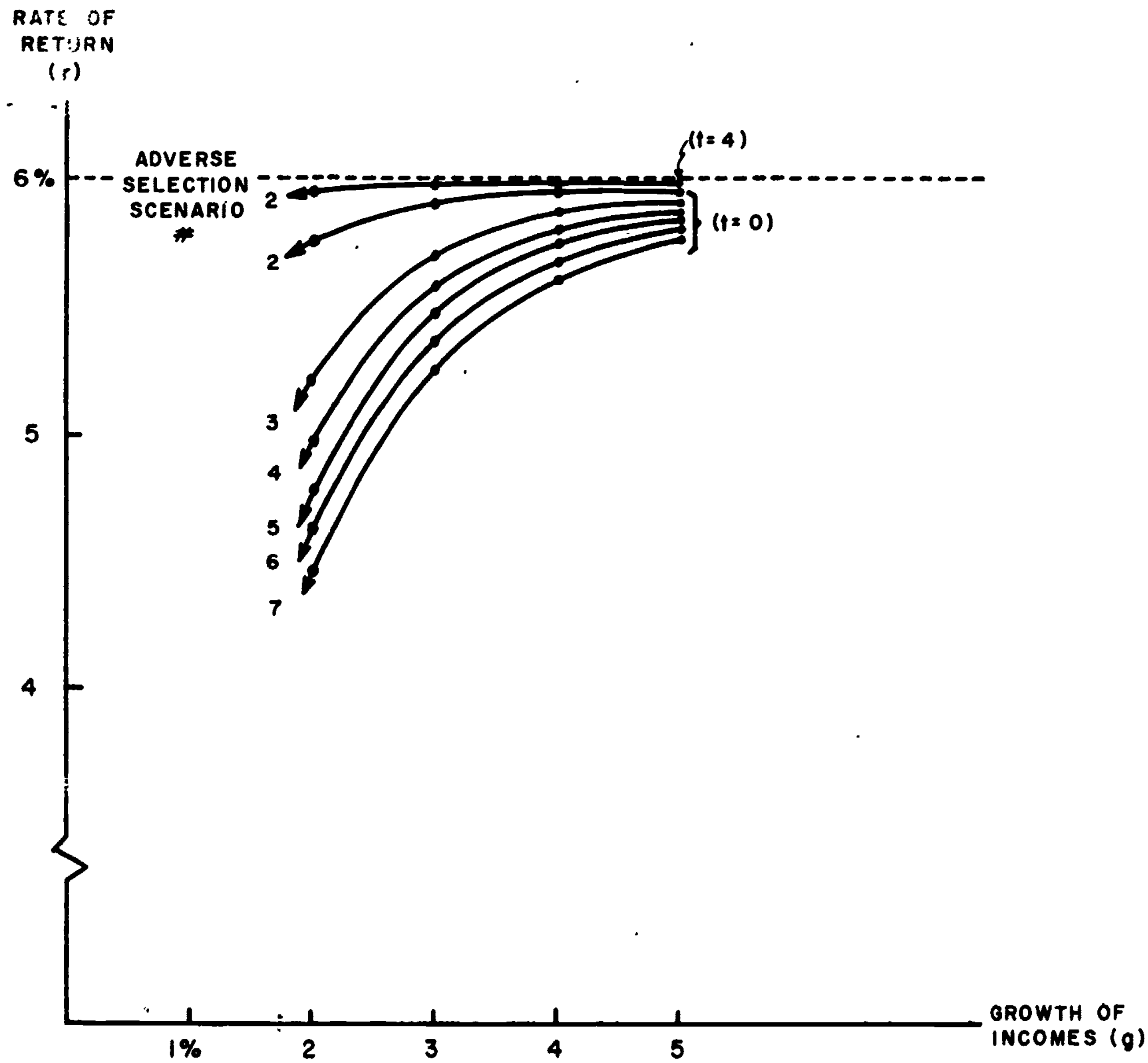
The low-earner's income insurance and the high-earner's payment insurance must then be compared by each group to see if the above "costs" are justified.

"Anticipated" adverse self-selection (i.e., what would r_c have to be to maintain the same r, given adverse selection) is explored in Table VIII and Figure IV. As expected, the coupon rate rises, but not substantially, as a result of the adverse selection. However, the variation of t and g exert a much more significant influence on r_c. This is illustrated by the family of curves in Figure IV (compare t = 0, 4 loci for adverse selection scenario = 2). As Table VIII corroborates, the sensitivity of the program to anticipated adverse selection increases dramatically when g, the growth rate of incomes, drops. In Figure IV we see that when g = 5%, increasing the severity of the adverse selection scenario has a negligible effect on the r_c required by the program. When g = 3%, however, adverse selection can make the program <u>infeasible</u> with the given τ. A grace period reduces this sensitivity by shifting these loci to the southwest, but the program <u>with</u> <u>such</u> a <u>τ</u> is still sensitive to low g's. Policy conclusion: higher τ's are needed if such adverse selection scenarios are anticipated.

The reverse exercise involves unanticipated adverse selection, or, <u>given</u> r_c and τ, what r would result under the same adverse selection scenarios as above, r_c and τ being chosen from the (r = 6%, g = 5%, no adverse selection) simulations. The results are set out in Table IX, and depicted in Figure V. The same pattern which emerged with anticipated adverse selection with low income growth can drop r substantially. A grace period of four years will guard against effects of unanticipated adverse selection by flattening out and raising the iso - r_c loci in (r,g) space, but dropping g still has significant effects with severe adverse self-selection. (See Figure V and Table IX.) Note that when

Figure V

Partially Contingent Program - Unanticipated Adverse Selection Coupon rate, r_c, (=6.17% for t=0, 6.51% for t=4) set to Yield Rate of Return, r=6%, with expected income growth rate, g=5%, and with no expected adverse selection when tax rate τ=.2%. Figure shows actual rate of return, r, as a function of the actual (not anticipated) growth of incomes, g, for various unanticipated adverse selection scenarios.



one combines scenario 7 (severe adverse self-selection) with $g = 5\%$, the rate of return is higher than it is when $g = 2\%$ and only a little adverse selection occurs (scenario 2). Hence, the rate of return is more sensitive to poor (too high) income forecasting than to unanticipated adverse self-selection with good income forecasting. Note, too, that scenario 1 (no adverse selection) always produces a 6% return here since coupon rate has been chosen to "anticipate" lower income growth; i.e., it has been chosen as the r_c from the partially contingent scheme with the same parameters, including g, but with no adverse selection.

In summary, adverse self-selection *per se* does not hurt the program. Poor forecasting of income growth and low τ's will damage its financial viability. This can be mitigated somewhat by allowing for a grace period. The caveat regarding our income data for these interpretations is as applicable here as above; interns are now earning much more relative to their expected lifetime earnings than they did during the 1960 census period. The best policy can be inferred immediately from Figure III - set τ high enough to ensure viability. Even $\tau = .40\%$ is not unattractive from the "insurance" point of view.

III. Evaluation of the Three Programs:

We cannot offer any simple evidence that one program is to be preferred over another. A semi conventional loan scheme such as we have outlined is preferable to a normal mortgage loan because its payments grow with the borrowers' ability to pay. We know from the simple arithmetic of compound interest, however, that the total amount paid back under a 25 year growing repayments plan will be significantly larger than that paid under a five year equal payments plan.

As we have stressed, the income contingent feature of the fully contingent scheme in some sense provides maximum insurance to the borrower, but the reduction of risk to the lender and the reduction of administrative costs offered by the partially contingent variant is of prime importance for small-scale applications. How might we compare the variants more precisely?

We know that the semi-conventional variant is the limiting case of the partially contingent variant in which $r_c = r$, τ is sufficiently large that in no period does any borrower elect the contingency option, and the rate of growth of repayments, γ , is the same for the partially contingent coupon as for the semi-conventional program. The semi-conventional variant is much like - but not necessarily identical to - the fully contingent variant in which τ is sufficiently high so that $r = R$. It should be stressed that at some point τ is sufficiently large to equate r to R, but if τ is increased further the pattern of repayments will be speeded up even though neither r nor R are affected by these further increases in τ.

Income distribution effects are certainly among the major reasons for proposing more flexible plans. The fully contingent plan favors lower income earners at the expense of higher income MD's. The early burden which a high opt-out rate puts on a rich MD, in spite of the fact that the high rate of return on his educational investment may justify it, could lead to adverse self-selection in these upper deciles. While this may not severely damage the program, as we have shown, the partially contingent program shifts the burden on these physicians to a later, higher income period. Certainly, the degree to which the early forced payments are a burden (especially for rich MD's) under the fully contingent scheme depends on the doctor's rate of time preference. In absolute terms, as already mentioned, the potential opt-out MD pays more under the partially contingent plan, due to interest compounding. Rather than expending a lot of effort trying to find tax loopholes to reduce his adjusted gross income, he can opt for the coupon, which is exactly what we want to keep administrative costs down.

Referring back to Figure II, we judge the area to the northwest of the region labelled "attractive" as such because too much "contingence" is being exercised; i.e., the τY_t^i option is selected by richer MD's. In other words, for the partially contingent plan, the administrators must set a relatively high τ and low coupon rate to make all but those in the lowest two or three deciles choose the tax repayment scheme. By "choose," of course, we mean year by year, since in each year, the choice between the two repayment options is open. Hence, a doctor starting out on his career may opt for τY_t^i for three or four years, and then stay with the coupon rate until the very end, when the γ% growth in repayments under the coupon scheme makes the tax more attractive. (See Table VIII (e) for example of this pattern.) Exercise of the "contingency" option will also be influenced by the grace period, since a low-income intern would obviously opt for the tax. Thus, extending the grace period shifts exercise of the contingency option from the early to the later years.

The "attractive region" also provides a margin of safety against unanticipated adverse self-selection combined with unanticipated low income growth. A more sophisticated way of projecting physicians' incomes seems desirable in view of the sensitivity of the latter two programs to changes in growth of incomes. Research on the elasticity of demand for education with respect to financing arrangements has yet to be done. More particularly, since this program is voluntary, we would like to know, given the investment decision, what is the elasticity of substitution between these and other means of financing that investment.

IV. The Pure Economic Theory Of The Ideal Contingent Repayment Loan Program

The major concerns of this study are largely for immediate policy implementation. We study the operating characteristics and stability properties of these variants. No plan strictly dominates any other. There is always a trade-off; e.g., greater stability and ease of administration is purchased at the price of reduced mutualization of borrower risk.

What program is best? There is no clear answer although we strongly suggest consideration of the so-called "fully contingent" EOB for national application in conjunction with the IRS and suggest consideration of the well-designed partially contingent EOB (PCEOB) for smaller scale application. In order to properly pose the question as to which contingent loan program is optional, we must consider partial and general equilibrium models of intertemporal decision-making under uncertainty. To construct a convincing but tractable model that allows for choices among work, education, leisure, consumption, and saving in an uncertain environment would be no mean feat in itself. Our problem is even more difficult: Since government taxation powers are of limited potency, in general the ideal CRLP would be only a "second-best" solution. Choosing an optimal EOB schedule is thus a problem in the barely developed field of optimal adverse-risk selection. Furthermore, transaction, enforcement, and administrative costs, as we have seen, play an essential role in selection of a "best" CRLP scheme. Here too, modeling is not likely to be easy. The general economic equilibrium theory with costly transactions is barely in its infancy; nonconvexities due to set-up costs abound and current mathematical techniques are not fully adequate.

It is outside the scope of this particular project to attempt to build a "definitive" model for the Ideal EOB. (The subject, however, fascinates us and we plan to make it an important part of future research effort.) Here we content ourselves with stretching some very simple models which illustrate the ideas of their section.

There is a further theoretical question which relates to the theory of the Ideal CRLP - the role of the institution of bankruptcy. Bankruptcy is obviously very important to any CRLP discussion. While the bankruptcy institution protects individual freedom from de facto slavery contracts, the same institution limits private investment in human capital by limiting lender security. The study of this special institution, which is obviously very important to the study of the Ideal CRLP, would take us so far afield into the theory of legal and economic arrangements, that we do not even attempt to sketch a "bankruptcy" model at this time.

A. Simple Aspects of Decision-making Under Uncertainty in the CRLF

For purposes of this subsection, we abstract from the choice of the student borrower as to quantity and quality of education, consumption and saving, and work and leisure. For simplicity the representative man is assumed to purchase college education and must (or chooses to) repay through the EOB arrangement. To keep things very simple, it is assumed that future pretax income is a single random variable unaffected by any decision of the borrower. In this very special and simple case, we have assumed away all incentive effects (thus assuming away all "moral hazards"). Thus, the EOB should be designed to provide insurance against lower-than-average earned income while supporting overall educational expenses.

Utility of the representative borrower is

$$U[(1-t)\ (Y_o+\tilde{Y}_e)]\ ,$$

where U[.] is the utility function, $\tilde{Y}_e$ is the random variable of earned income, Y_o is other income, and $t \in [0,1]$ is the average rate of income taxation. Following von Neuman and Morgenstern, we postulate that the individual desires to maximize expected utility,

$$E\{U[(1-t)\ (Y_o + \tilde{Y}_e\ )]\}$$

In the case of this subsection. the borrower has no decision variable at his own disposal - giving his probability belief EV is given after the government specifies the tax rate, t . We assume that the representative borrower is risk-averse, that is, the second derivative of his utility function is negative, $U'' < 0$.

The government must balance its education budget,

$$P = \sum_{i=1}^{i=\tau} y^i\ t\ (y^i)$$

where $y^i = Y_o^i + Y_e^i$ is income of borrower i , $t(y^i)$ is the average tax rate of borrower with income y^i , and B is total cohort borrowings including interest charges. If you like, the sum in the above may be approximated by integral of densities, so that

$$B = \int t(y)yf(y)dy ,$$

where f(y) is the density of individuals with income y . Following Bentham, we may wish to maximize the simple integral of expected utilities

$$\int E\{U[(1-t(y))y]\}f(y)dy$$

subject to the balanced-budget constraint. (Of course, the balanced-budget constraint can be easily modified to allow for government subsidy of education.)

The government's policy is the function, t(y), the full tax schedule. Lump-sum taxes are disallowed; t depends solely on y. By solving the Euler equation to the above isoparametric problem, the optamizing tax schedule is found. In the degenerate case where each individual has the same utility function, the same belief about the random variable $\tilde{Y}_e^i$, and the same Y_o^i , then since $U''< 0$, optimal tax is to confiscate all above-mean income and give subsidies to all others to bring each individual to the mean income. (All of the above implicitly assumes that a very strong law of large members applies to government tax revenue; the probability limit of average revenue (revenue per taxpayer) is equal to the expectation of average revenue.)

B. The Education Quantity and Quality Decision and Adverse Self-Selection.

Here we focus on the effect of taxes (or repayment-taxes) on the individual's educational effort and expenditure decisions. For simplicity, at this stage, we abstract from the intertemporal aspects of investment in human capital, the consumption aspects of higher education and the riskiness of return to investment in educational capital. The simple model will be of some use in studying the question of adverse self-selection.

The model studied is based on one exposited by E. S. Phelps.[1] The Phelps paper in turn employs the explicit educational choice model put forward by E. Sheskinski.[2] The very recent resurgence of interest in optimal income taxation which provides a theoretical framework for models of this type is due to J. A. Mirrlees.[3]

Assume that individuals - potential student borrowers all - have identical preferences, but they differ in ability to earn wage and salary income according to differences in a parameter n, $n \in [0,\infty)$. Let F(n) be the cumulative distribution of individuals with ability n, so that f(n) can denote the density of individuals of ability n.

$$F(n)=F(0)+\int_0^n f(s)ds \ ,$$

so that

$$F'(n)=f(n)>0$$

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1 E. S. Phelps, "Taxation of Wage Income for Economic Justice," Department of Economics, Columbia University, New York, New York, 10027. August 1972.

2 Reference [12].

3 Reference [7].

with

$$F(C)\geq 0 \quad \text{and} \quad F(N)=1 ,$$

where N is the highest ability.

Let x be an index of time and resources spent in education. Assume that ability and education interact in a multiplicative way so that

$$y = nx ,$$

where y is pretax income for an individual with ability n and education x. The problem for society is to choose an optimal system of taxation and transfers to redistribute income while not neglecting costs of interfering with educational incentives.

Let the net tax function be h(y) so that after-tax disposable incomes are given by $z(y)=y-h(y)$. To bring out the redistribution-efficiency trade-off most clearly, replace the Benthamite social welfare function of the previous subsection with the Rahlsian criterion of maximizing the utility of the worst-off individuals (in this case those with zero productive ability, n=0). Notice that the Rahlsian criterion does not call for confiscatory taxes. The energy of the ablest needs to be harvested for the least able even with this extreme social welfare function.

For analytic convenience we can follow Phelps in writing

$$z(y)=y+g-t(y) ,$$

where

$$h(y)=t(y)-g ,$$

so that the constant g has the interpretation of minimum-disposable-income and $t(0)=0$.

The repayment-tax schedule $t(y)$ must be chosen to maximize minimum utility, $u(g)$ subject to

$$g=\int_0^N t[y(n)]f(n)dn - \gamma-\sigma$$

where γ is government expenditure and σ is the desired government budgetary surplus, and subject to individual responses to the tax schedule which will be discussed next.

Each individual maximizes his utility of consumption, $u(c)$. The cost of an education of type x is $j(x)$, so by individual budget balance,

$$c+j(x)=y-t(y)+g \ .$$

Simple utility-maximization yields

$$\partial c/\partial x = n(1-t'(nx)) - j'(x) = 0$$

for interior maximum.

We have set the stage for a detailed derivation of an optimal repayment tax rate $t(y)$. While interesting properties can be derived, this is not the place to do so given the extreme simplicity of the model. The intention here - as it is throughout Section IV - is to discuss the elements of a theory of ideal student finance for higher education.

C. Theoretical Aspects of Transactions Costs in Alternative Student Financing Schemes.

Traditional general equilibrium economic models assume the absence of transactions costs including costs of marketing, government costs of taxing and individual transactions costs imposed on individuals as a function of alternative legal and administrative arrangements. The very recent economic literature has attempted to incorporate such costs. See e.g. [4] and [6]. One notable difficulty in extending the traditional models is the obviously non-convex nature of transactions sets: Transactions costs functions are typically of the set-up cost type (with zero marginal costs) or at least exhibit sharply increasing returns-to-scale.

As with all industries characterized by increasing returns to scale, there is a strong argument for a government role in setting up markets and in designing legal and institutional arrangements. The important technical lesson is that the non-convexity can be expected to require digital (or integer) programming techniques to choose the socially optimal subset of feasible social-institutional-market arrangements.

In terms of the social financing of students in higher education, this suggests that there may be strong efficiency losses from retaining a diversity of federal financing programs which, of course, must be weighed against the ovbious gains to the student borrower of the existence of choice among financing schemes.

The reader of this report will note that in evaluating the particular EOB plans great emphasis was placed on relative transactions costs. While we hope that our arguments are persuasive, <u>we keenly feel the lack of quantitative basis for transactions enforcement-administrative costs in this study</u>. The failure to theoretically and quantitatively account formally for such costs is a subject of general concern in modern economic theory and econometric practice. (We plan in future research to address ourselves to these important theoretical questions and to apply the results to the area of educational finance.)

APPENDIX A - INCOME DATA

In order to obtain the most realistic and accurate analysis of contingent repayment loan schemes, it is highly desirable that we work with disaggregated income data. Such data also allows us to observe carefully the cross-subsidization which occurs during the repayment years between the "high-earners" and "low earners" of the borrowing population. Toward this end, we divide the borrowers into ten classes, or deciles, each of which represent ten percent of the total number of borrowers. We then assume that all members of a decile have incomes equal to the average for that decile and use these incomes to compute the repayment flows for all ten deciles.

Disaggregated census income data are highly limited in scope. Since the highest income class specified by these data is $15,000 and above, they fail to give a useful representation of the income distribution of the physician population. It is however possible to generate a satisfactory income distribution by combining the mean and median census income data with a frequency distribution which is considered applicable to such data. The frequency distribution which we have chosen is the Paretian distribution,* whose density function is"

$$f(X) = \begin{cases} rA^r / X^{r+1} & \text{for } X \geq A \\ 0 & \text{for } X < A \end{cases}$$

where r and A are parameters and X is the level of income.

*The Pareto and the lognormal distributions are the two most obvious candidates for income frequency distributions. (We chose the Pareto because of the parametrization for A, which can be positive, especially appropriate for physicians. This enables us to neglect all physicians with incomes lower than A.)

This function may be used to determine the frequency of any income class from X_1 to X_2 by evaluating the definite integral $\int_{X_1}^{X_2} f(X)\,dX$ (e.g., if $\int_{20,000}^{30,000} f(X)\,dX$ equaled .21 this would imply that 21% of the physician population was earning between \$20,000 and \$30,000). In particular, we know that for <u>any</u> frequency distribution f(X), the following two equalities are valid:

(1) $\bar{X} = \int_{-\infty}^{\infty} Xf(X)dX \quad (\bar{X} = \text{mean})$

(2) $.50 = \int_{-\infty}^{\tilde{X}} F(X)dX \quad (\tilde{X} = \text{median})$

Since we know that for a Paretian distribution f(X) the definite integral $\int_{-\infty}^{A} f(X)\,dX$ equals zero, these two equalities may be expressed as:

(3) $\bar{X} = \int_{A}^{\infty} Xf(X)\,dX$

(4) $.50 = \int_{A}^{\tilde{X}} f(X)\,dX$

Substituting the Paretian form rA^r/X^{r+1} for f(X) and simplifying we obtain:

(5) $\bar{X} = rA/r-1$ or   (7) $A = \bar{X}(r-1)/r$

(6) $\tilde{X} = (2A^r)^{1/r}$ (8) $A = \tilde{X}/2^{1/r}$

Equating (7) and (8) we obtain:

(9) $r(\bar{X} - \tilde{X}/2^{1/r}) - \bar{X} = 0$

This in turn may be used to solve, via Newton's method, for r when the mean and median for a particular segment of the physician population are known. Finally, this value of r may be substituted into (7) or (8) to obtain the value of A.

The mean and median census income data for each of four age groupings of the 1959 physician population and the corresponding values for r and A are presented in Table A-1.

If any justification is needed for not using the census income by census, the data in Table A-1 provide it. Not only are the mean and median incomes for physicians above $15,000 in all but the fledgling age range, but A, the parameter of the distribution below which the frequency is <u>zero</u>, is <u>above</u> $15,000 in two of those three cases as well. Hence, if the Pareto distribution is a good approximation to the actual distribution, there were very few doctors between ages 35-54 earning <u>less</u> than $15,000 in 1959, whereas the census classes lump all doctors earning <u>more</u> than $15,000 into one class.

From r and A, we may calculate what may be called income "dividers" for each of the ten deciles of the distribution. A divider separates one decile from the next; it is the income level at the bottom of a decile. The divider for decile 1 is just equal to A, since that is taken to be the very lowest income of the distribution (frequency of incomes less than A equal zero). From there, the remaining dividers may be calculated in sequence:

$$\text{decile \#2:}\quad .10 = \int_{A}^{D_2} f(X)\,dX = \left[-\left(\frac{A}{X}\right)^r\right]_{X=A}^{X=D_2}$$

(solve for D_2, the divider for decile #2)

$$\text{decile \#3:}\quad .10 = \int_{D_2}^{D_3} (f)(X)\,dX = \left[-\left(\frac{A}{X}\right)^r\right]_{X=D_2}^{X=D_3}$$

(solve for D_3)

and so on for deciles 4-10.

The values for these dividers thus obtained are presented in Table A-2. Note that the sixth divider is equal to the median of Table A-1, a result which follows from our definition of divider (the sixth divider separates the first five deciles from the second five).

From these dividers, we now calculate the average income by decile for each of the four age groups (i.e., income for physicians of age 30, 40, 50, 60). For the first three age ranges we use simply the arithmetic mean of dividers 1 and 2, 2 and 3, 3 and 4 respectively. For the highest age range, a slightly different approach is required.

By definition of our Pareto distribution, we know that $\int_A^\infty f(X)\,dX = 1.0$ and $\int_A^{D_{10}} f(X)\,dX = .90$ where D_{10} is the income divider for decile ten. By subtraction we obtain $\int_{D_{10}}^\infty f(X)\,dX = .10$. Finally, if $\tilde{X}_{10}$ equals the "median" between infinity and the tenth divider, we can solve $\int_{D_{10}}^{\tilde{X}_{10}} f(X)\,dX = .05$ for $\tilde{X}_{10}$ to obtain the "average" for decile ten.

The results obtained from the above two computational procedures are presented in Table A-3.

Finally, to obtain incomes for each age between 25-64, the income matrix of Table A-3 was linearly interpolated between the four age benchmarks. If the interpolation yielded a negative value, we took these to be zero. This occurred in 19 of 400 cases, naturally all in the first two or three years (ages 25-27). Recognizing the existence of non-salary income among physicians, which may be received either because of physicians' increased knowledge of investment opportunities or larger wealth from which to accumulate capital gains income, or both, a simple blow-up factor of 6% was used to inflate the incomes obtained by the interpolation procedure. These results are presented in Table A-4.

The cross-sectional matrix was converted to a matrix giving incomes over time for the 1977 cohort,[1] the nominal growth rates as follows:

Period	Graduates	Dropouts
1960-70	7%	4.5%
1970-71	8%	5.6%
1971-72	7%	4.9%
1972-73	6%	4.2%
1973-74	5%	3.5%
and thereafter	5%	3.5%

Note that this growth is in addition to that yielded by aging (implied in the cross-sectional matrix). This final income matrix (Table A-5) was used as input to our contingent repayment calculations.

The high rate of growth in the demand for physicians' services will continue, and we expect demand to continue to exceed the supply for a while yet. Since we envision the program would have a fairly substantial effect on the number of physicians graduated, we assume that excess demand will be lessened within a few years. Further, we assume that the introduction of paramedical personnel in the next few years will yield more "doctor-hours" from physicians, increasing the effective supply. Naturally the income scenario is somewhat arbitrary; still, we feel it is reasonable. As mentioned in the text the growth rate projections for post-1974 are varied in our computations to test

[1] Including graduates and dropouts.

the robustness of the program to variations in these projections. In 1968, Medical Economics projected a 5.4% annual rate of growth of physicians' incomes for 1968-78. Our projections are somewhat higher, based in part on inflation, and in part on the expected growth in the demand for physicians' services. For example, a 30 year old in the fifth income decile would have a 1980 income computed as follows:

1980 income = $(4810)(1.07)^{11}(1.08)(1.07)(1.06)(1.05)^{7}$ (graduated in 1977 1959 + 11 + 1 + 1 + 7 = 1980 at age 27)

TABLE A-1

Cross-sectional mean and median physician income data in 1959 and Pareto distribution parameters resulting from these means and medians (source:

AGE RANGE	MEAN	MEDIAN	r	A
25-34	$ 8,990	$ 4,877	$1,511	$ 3,041
35-44	23,302	19,491	2,955	15,415
45-54	25,045	20,788	2,876	16,335
55-64	21,499	16,949	2,473	12,807

TABLE A-2

Income "dividers" for deciles resulting from Pareto distribution of cross-sectional physician income data in 1959

	A G E R A N G E			
DECILE	25-34	35-44	45-54	55-64
1	$3,041	$15,415	$16,335	$12,807
2	3,261	15,975	16,945	13,364
3	3,525	16,624	17,653	14,016
4	3,851	17,393	18,492	14,793
5	4,264	18,325	19,511	15,745
6	4,811	19,491	20,788	16,949
7	5,577	21,020	22,465	18,549
8	6,746	23,170	24,829	20,837
9	8,822	26,578	28,589	24,549
10	13,956	33,606	36,382	32,490

TABLE A-3

Average 1959 cross-sectional physician income by decile

DECILE	AGE RANGE 25-34	35-44	45-54	55-64
1	$ 3,151	$15,695	$16,640	$13,085
2	3,393	16,300	17,299	13,690
3	3,688	17,009	18,073	14,404
4	4,057	17,859	19,002	15,269
5	4,538	18,908	20,149	16,347
6	5,194	20,256	21,627	17,749
7	6,161	22,095	23,647	19,693
8	7,784	24,874	26,709	22,693
9	11,389	30,092	32,486	28,520
10	22,078	42,491	46,300	42,999

TABLE A-4

Cross-sectional 1959 physician income data for selected ages by decile (includes extra 6% for non-salary income) in dollars

DECILE	AGE 25	30	35	40	45	50	55	60	64
1	0	3,340	9,998	16,637	17,138	17,638	15,754	13,870	12,363
2	0	3,596	10,437	17,278	17,807	18,337	16,424	14,511	12,981
3	0	3,909	10,969	18,029	18,593	19,157	17,213	15,269	13,713
4	0	4,301	11,616	18,930	19,536	20,142	18,163	16,[illegible]85	14,602
5	0	4,810	12,426	20,042	20,700	21,358	19,343	17,328	15,715
6	0	5,505	13,488	21,471	22,198	22,924	20,869	18,814	17,170
7	0	6,531	14,976	23,421	24,243	25,066	22,970	20,875	19,198
8	0	8,251	17,309	26,366	27,339	28,312	26,183	24,055	22,352
9	2,160	12,072	21,485	31,897	33,166	34,435	32,333	30,231	28,540
10	12,563	23,402	34,222	45,041	47,059	49,078	47,329	45,579	44,180

TABLE A-5

Income over time for graduating class of 1977
(ages 27-64, corresponding to repayment years 1978-2015)
In dollars

	AGE								
DECILE	27	30	35	40	45	50	55	60	64
1	0	12,117	46,248	98,314	129,255	169,787	193,548	217,482	235,624
2	0	13,049	48,327	102,105	134,308	176,510	201,765	227,505	247,353
3	0	14,182	50,791	106,545	140,235	184,408	211,467	239,406	261,351
4	0	15,601	53,782	111,869	147,346	193,887	223,148	253,783	278,309
5	747	17,451	57,537	118,441	156,124	205,540	237,636	271,700	299,528
6	2,222	19,973	62,455	126,885	167,421	220,672	256,388	295,002	327,239
7	4,554	23,693	69,341	138,405	182,847	241,283	282,199	327,314	365,899
8	8,744	29,934	80,144	155,812	206,195	272,526	321,670	377,176	426,006
9	19,014	43,798	101,796	188,498	250,146	331,472	397,227	474,024	544,130
10	52,498	84,903	158,453	266,166	354,929	472,423	581,444	714,660	841,992

APPENDIX B - DEATH AND DROP-OUT PROVISIONS

Deaths:

All financial aid programs require that the terms of repayment be fixed at the time of the contractual agreement. It is therefore necessary that these terms include some insurance to the lender that unexpected defaults will not adversely affect his investment. Assuming that an educational debt incurred by a student will not be charged to his estate if he dies before satisfying his repayment obligation, two forms of insurance are open to the lender. First, he may include in the contractual agreement a compulsory life insurance policy which names the financing entity as beneficiary. Alternatively, he may take into account the probability of default caused by the borrower's death when calculating the repayment terms necessary to earn the desired return. We have chosen the latter option in our program and have used five year projected survival rates published by the Public Health Service in 1964. The average number not surviving in each year of the five year periods is subtracted from the total number of surviving borrowers to obtain the number of persons making repayments in that year. We assume that no deaths occur while the student is still in school.

See Table B-1 for the results of this death provision in a hypothetical program extending loans to 10,000 students which graduate in 1975.

Dropouts:

We assume that a fixed (9%) percentage of borrowers will drop out of medical school after one year. Historically, this is a percentage point or two below the average drop-out rate (11%), and if too low, would bias our tax rate computations downward somewhat. However, the drop-out trend seems to be declining, and we feel that the pressure of the military draft will ensure the continuation of that trend, since medical school enrollment guarantees a deferment.

TABLE B-1

Year	#Survivors
1975	10,000
1980	9,912
1985	9,826
1990	9,723
1995	9,478
2000	9,090
2005	8,503
2010	7,683
2015	6,585

APPENDIX C - CASH FLOW CALCULATIONS

The algorithm which we use for determination of cash flows is applicable to any of the three types of repayment schemes. It is used in our program to calculate not only the aggregate cash flow over all ten deciles, (graduates and drop-outs) but also when considering the opt-out feature of the fully contingent repayment scheme. One need only specify the prevailing interest rate on borrowed funds, the loan schedule and the repayment schedule.

The algorithm is as follows:

Given: L_i = loan extended at beginning of year i

R_i = repayment made at end of year i

r = prevailing interest rate

Calculated:

I_i = interest due at end of year i

P_i = principal paid in year i

C_i = cash flow for year i

D_i = outstanding debt at end of year i

$$I_i = \left(\sum_{j=1}^{i} L_j - \sum_{j=1}^{i-1} P_j\right) x(r)$$

$$P_i = R_i - I_i$$

$$D_i = D_{i-1} + L_i - P_i$$

$$C_i = R_i - L_i - I_i = P_i - L_i$$

We solve for one parameter, given the others, such that the absolute value of the outstanding debt at the end of year T + t is less than

\$100 (our computational tolerance). This is equivalent to solving for say r, given τ, in the fully contingent variant, such that

$$250 \left[\sum_{j+1}^{4} \left\{ \sum_{i=1} n^{i} (1+r)^{j} \right\} \right] = \sum_{\theta=1}^{T} (1+r)^{-(\theta+t)} \left[\sum_{k \in G} n_{\theta}^{k} P_{\theta}^{k} + \frac{1}{2} \theta \sum_{k \in D} n_{\theta}^{k} P_{\theta}^{k} \right],$$

where

$i \in G, D$ if $j \leq 2$,

$i \in G$ otherwise, and

n_{y}^{i} is the number of persons in each DEA (Decile-Education-Age) cell in year y; and the other parameters are as in the text. Note that we use n_{1}^{i} on the left-hand side, on the assumption of no mortality during medical school.

APPENDIX D - SURVEY OF INCOME-CONTINGENT PLANS

Recent proposals for income-contingent student loan repayment plans have met with sharply differing degrees of success. The proposals may usefully be separated into three categories:

I. Plans which restrict their borrowing populations to those students within a single university or to separate colleges of a university. Initial funding for such plans generally draws on the school's unrestricted endowment funds or alumni donations.

II. Plans which attempt to mutualize risk (and thus gain access to external funding sources) via a consortium of schools whose borrowing populations share similar borrowing preferences and projected future income streams.

III. Plans which may be either university-specific or available to a broad (e.g. statewide) student body but gain direct funding or debt guarantees from governmental bodies.

Of course, these criteria for separation is somewhat arbitrary and intra-category differences will often exceed those between categories. The three divisions do, however, represent sharply different financing philosophies and are thus useful for investigation into probable future directions of income-contingent plans.

1. Successfully implemented proposals have generally fallen within the first category. Brief discussion of the essential characteristics of four such implementations follow.

A. Yale University, the first major school to implement the income contingent plan, allows all its students to participate in the program, each being permitted to borrow that portion of his tuition which represents an increase from the 1970-71 tuition level. The repayment tax rate on income is set at .4% per $1000 borrowed, the maximum repayment period at 35 years. This tax rate repayment period combination implies extremely conservative income growth assumptions, as is implicit in the Yale informational pamphlet, which estimates that the borrowing cohort's debt obligation will be satisfied 10-12 years before the end of the maximum repayment period. This conservatism is also reflected in the $29 required minimum annual payment per $1000 borrowed ($29 x 35 years ≅ $1000, thus a stream of the minimum repayments would repay principal only, providing a long-term, zero interest rate loan). Borrowers may "opt out" of the program at any time with a final payment which would cover a loan 50% larger than the loan actually taken out (plus interest on that 150% amount). Yale student response to the loan offering has been enthusiastic, perhaps surprisingly so, considering the rather stringent repayment terms.

B. Duke University has implemented a loan program very similar to that of Yale but differs significantly in that:

(i) it attempts to minimize cross-subsidization from low to high earners by separating the various colleges within the university into distinct borrowing cohorts, so that the repayment obligations of a medical school cohort will end sooner than the contemporaneous undergraduates;

(ii) it is financed solely through internal monies;

(iii) it limits the borrower to $500-1,000 per year, not reflected in a tuition increase;

(iv) it operates under more realistic repayment terms (tax rate = .36% per $1,000 borrowed, repayment period = 30 years);

and (v) it allows the borrower to begin repayment after one full year of full-time employment. This is actually a sophisticated "grace period" provision, inasmuch as it varies among borrowers.

C. Stanford Business School

M.B.A. students at the Graduate School of Business at Stanford are given the opportunity to participate in a loan program whose terms of repayment are very similar to those of our "partially-contingent" variant. All students are nominally eligible to participate, but participation patterns may be non-uniform across income deciles because the school encourages its students to exhaust all other funding sources (e.g. national direct student loans, federally or state insured loans and parental and personal assets) before making application to the school's loan program. Currently, the maximum total loan which will be extended to a student is $8,000, which more than covers two years' tuition ($3,210/year). The essential repayment terms are as follows:

(1) Beginning year of repayment: Borrowers begin repayment immediately after graduation, unless granted a deferment because of continuing education at Stanford or elsewhere. This is similar to Duke's terms in that a "grace period" will be granted to some students, but not others.

(2) Terms of repayment: Each borrower will repay on a conventional five-year repayment schedule (60 equal monthly repayments) unless he chooses (at any point

in the five-year period) to switch to an optional repayment schedule. This optional schedule runs for 10 years, with repayments on a graduated schedule, each payment being 6% larger than the last. If at any point in this ten years, the borrower anticipates that a required loan repayment* will exceed 8% of his income over the next year, he may defer the excess to an eleventh year. Deferred repayments in this eleventh year will be equal in size and, again, must not exceed 8% of the borrower's income in that year. Deferments to twelfth, thirteenth, etc., years will thus be possible if a borrower's income was especially low over the entire repayment period. This "contingency option" is called a "payment limit provision" by the school.

(3) Interest charged on loan (r): Stanford expects to be able to borrow at the going prime rate and thus uses an estimate of this rate to determine the probable future repayment schedules for all borrowers. Administrative costs and expected deaths and defaults add an additional 1% interest to the conventional 5-year plan or an additional 1 1/2% interest to the "partially-contingent" 10-year plan.

* Including any required loan repayments to other funding sources such as NDSL and Federal/State insured loans.

It is significant to note that, in the language of our "partially contingent" variant, the optional repayment tax rate, τ, is variable, ranging from 1% (for the maximum loan of $8,000) to a very large rate (16% for a loan of $500). This variable rate will, of course, decrease the likelihood of contingency exercise by students who took out small loans, thus giving a subtle deferment advantage to large borrowers.

D. <u>University of Pennsylvania Law School</u> is offering (Fall 1972) a small pilot income-contingent program, making available ten separate $1,000 loans in its first year of operation. It is financed exclusively by a short-term pledge from an interested alumnus and has set a repayment ceiling of .50% of the borrower's income and a fixed repayment period of 20 years. It differs from the Yale, Duke and Stanford Business School programs by offering yearly repayment choices, where the borrower may opt for a "fixed" repayment from a schedule whose payments grow at 5% each year. (See discussion of the "partially contingent" loan schemes, pp. 11-14).

2. Consortium attempts have been quite unsuccessful to date, as may be readily inferred from the absence of any such financing proposals in the recent literature on the income-contingency issue. Three

representative failures are sketched below, with emphasis on the causes for their rejection.

A. Work toward a consortium of 10-12 graduate business schools was carried out in January, 1971, the corsortium to be based in the Wharton School and to draw its initial funding guarantees from foundation sources. Foundation and institutional reluctance to join in the proposed consortium led the income-contingent scheme to an early death. Wharton subsequently considered an independent income-contingent program but chose instead a conventional five-year, fixed repayment loan offering which satisfied the debt obligation at an interest rate of eight percent. Student interest and participation in this program was predictably low and plans are currently being made for a shift to the federal GSL program.

B. Another feasibility study, made early in 1971 under the auspices of the Sloan Foundation, focused on a proposed consortium of the five Philadelphia medical schools. It examined two alternative programs: (1) a "normal" income-contingency scheme with a repayment tax rate set at .35% per $1000 borrowed and (2) a schedule of growing fixed repayments where the repayment period would fall somewhere between 15 and 25 years and the growth rate of repayments would be set between 2 and 16 per cent. A strong recommendation emerged in favor of the fixed repayment schedule, primarily because of financial uncertainties and adverse self-selection fears.

C. A third investigation headed by Dean Bernard Nelson of the Stanford Medical School and funded by the Sloan Foundation (early 1971) considered a possible consortium of California medical schools. The investigation produced a strongly negative report on the income-contingent mode of repayment, based on such factors as:

(1) Costliness to the student of long-term repayment periods,

(2) Riskiness to medical schools which would be guaranteeing immense outstanding debt balances,

(3) Lack of information to be gained from a brief, costly pilot program.

Parameters for the income contingent plan which were considered were:

(1) Repayment tax rate = .50% per $1000 borrowed,

(2) Opt-out rate = 10%,

(3) Repayment period = 25 years,

(4) Assumed 5% annual income growth,

(5) $29 minimum annual repayment per $1000 borrowed.

3. The final category is one for which no strong evidence of feasibility or attractiveness has yet emerged, but which will likely serve as a model for some future experimental programs. Its primary difference from the other two categories lies in its dependence on governmental legislation and appropriations.

A. Harvard University has begun (Fall 1972) a loan program for Harvard and Radcliffe undergraduates which will meet all requirements for inclusion under the umbrella of the Federal Insured Student Loan Program. The borrowing population is limited to those students with adjusted family income (defined to be 90% of AGI less $675 per declared exemption) less than $15000, each student being permitted to borrow $1000-$1500 per year. The repayment period is set at 5-10 years, with a possible three year extension of repayments if the borrower's income has been low enough to qualify for the maximum repayment ceiling (6% of annual income). The repayment ceiling implies a tax rate of 1 - 1 1/2% per $1000 borrowed (four year's borrowing of $1500 per year yields an effective tax rate of 1% per $1000 borrowed). This extremely conservative tax rate is well justified, considering the projected incomes of eligible borrowers and the lower repayments in the normal stream of fixed repayments.

B. Various state legislatures (Ohio, Illinois, Oregon) have considered and rejected bills which would require that all state college and university students repay the implicit loan, or subsidy, which provided them with lower tuition levels than students at comparable private institutions. This subsidy was estimated at $3500 for four years of education in the Ohio Plan. These legislative proposals were income-contingent only in the grossest sense, in that they allowed reduced or zero repayments for students whose incomes fell below a specified level. The rejections of such bills speak for the general legislative hesitancy to threaten the strongest selling point of state institutions for higher education - relatively lower direct costs to the student. If, however, state colleges and universities continue to find it necessary to increase tuition levels, adverse student and citizen reaction can be expected to grow proportionally. Such reaction could well destroy the existing legislative opposition to "deferred tuition" plans at the state level and lead to a renewed interest in the subsidy-repayment schemes.

APPENDIX E - THE INCOME-GENERATOR COMPUTER PROGRAM AND THE INCOME-INFLATOR COMPUTER PROGRAM

The Fortran program to generate income matrices by age, decile and education consists of nine subroutines and functions: MAIN, INTERP, NEWTON, FR, DERF, DERF1, FX, FA, and FINC. The program requires 10008 types for code and 13272 types for arrays.

The program requires as input the mean and median incomes for four age ranges as well as a starting estimate for the values of the parameter r used in the assumed Pareto distribution. These are necessary for the two educational classifications: Graduates and drop-outs. For the drop-outs, no distribution of incomes is compared; the incomes across all deciles are set equal to the mean. This is a criterion imposed by our data: No median data were available.

The output produced includes that summarized in Appendix A; values for r and A for each age range (25-54, 35-44, 45-54, and 55-64), income "dividers" by decile, income matrix by age range and decile, and an income matrix for ages 27-64 and by decile. For each of these, the calculations are described in Appendix A.

The resultant matrices, each 40x10 in the case of our data, are written as an unformatted file for input to our simulation of cash flows program. They could equally well be punched on cards by the program. In the first case, appropriate job control cards are required for the file to be kept on disk or tape. In the second case, the white (1) statements should be replaced with a formatted punch (or write (IP,)) statement. Note that, in most cases the standard card reader, printer and punch units are IN, IO, and IP, set in a data statement in the main program (to 5,6, and 7).

DATA INPUT

Card 1: Format Card (cols. 1 - 72)

This is a Fortran format, column 1 being a left parenthesis, and the last column a right parenthesis. It describes the following list:

Parameter	Variable Type	Purpose
Age 1	Integer *4	Indicates age range
Age 2	"	"
Mean	Double precision (Real *8)	Mean Income
Median	"	Median Income
STR	"	Starting est. for r

Thus, a sample format card might be: (2I4,3F10.0).

Card 2 - 9:

Values of this list for four age ranges for graduates, then for drop-outs.

Subroutine Summary

Subprogram Purpose

MAIN calls all others; data read and written here

INTERP does linear interpolation of incomes between age ranges (25-34 centered on 30, 34-44 centered on 40; so at extremes, interpolation done between 0 and 30, and 60 and 64) - produces income starting with age 27.

NEWTON* Newton's method for evaluation of nonlinear function FR, whose arguments are MEAN, MEDIAN, R, and 7

* See IBM Scientific Subroutine package.

FR solve for r in terms of mean and median (equation 9, Appendix A)

DERF corresponding 1st derivative

FA evaluates FX for income dividers $(=.1 \int_{-\infty}^{\infty} FX)$

Subprogram	Purpose
FX	evaluates Pareto density for income divider calculation (in terms of A and r)
DERF1	corresponding first derivative
FINC	evaluates last income value, say X, where $F(X), = .5\ (1.-F(DIV_{10}))$, DIV_{10} = 10th decile income divider $F(.)$ = Pareto density. Hence, DERF1 is the corresponding first derivative.

PROGRAM PERFORMANCE

For MBA data, requiring only 20-year income matrices, 6 sec. of CPU and 10 sec. of channel time were used on a 360/75. (Cost = $1.04). Questions about this program should be referred to either R. Berner or M. Johnson.

INCOME GENERATOR PROGRAM

```
C     MED SCHOOLS INCOME MATRICES
      DIMENSION FMT(18),INC(10,4),YM(10,40),YC(10,40)
      REAL*8 MEAN,MEDIAN,R,A,DIV(10),INC,X,EPS,STR,YC,Y(2,10,40),MULT,YM
      DOUBLE PRECISION FR,DERF,FX,DBLE,DERF1,XP,FA,FINC,DMAX1
      INTEGER AGE1,AGE2
      EXTERNAL FR,DERF,FX,DERF1,FA,FINC
      DATA IN,IO,IP /5,6,7/
      REWIND 1
      READ (IN,500) FMT
      DO 101 L=1,2
      WRITE(6,515)
      DO 100 J=1,4
      READ(IN,FMT) AGE1,AGE2,MEAN,MEDIAN,STR
      WRITE(IO,501) AGE1,AGE2,MEAN,MEDIAN,STR
      IF(L.EQ.2)   GO TO 111
      EPS=.1D-6
      IEND=100
C     CALC. R FROM F(R)=0 W/NEWTON'S METHOD
      X=0.D0
      CALL NEWTON(R,FR,DERF,STR,EPS,IEND,IER,MEAN,MEDIAN,X)
C     ERROR RETURNS
      IF(IER-1) 2,10,20
   10 WRITE(IO,502) IEND
      CALL EXIT
   20 WRITE(IO,503)
      CALL EXIT
C     CALCULATE INCOME DIVIDER ARRAY
    2 A=MEDIAN/(2.000**(1.000/R))
      DIV(1)=A
      WRITE(6,504) R,A
      DO 30 I=2,10
      X=DIV(I-1)
      IF(FX(A,R,X).LE.1.D-1)   GO TO 31
      DIV(I)=A/(((-1.D-1)-FX(A,R,X))**(1.D0/R))
      GO TO 30
C     IF LOWER LIMIT ON DEFINITE INTEGRAL OF PARETO DIST'N < .1, SOLVE
C     F(B)-F(A)=.1 FOR B W/ NEWTON'S METHOD
   31 STR=A+DBLE(FLOAT(I))
      CALL NEWTON(XP,FA,DERF1,STR,EPS,IEND,IER,X,A,R)
      IF(IER-1) 50,51,52
   51 WRITE(IO,502) IEND
      CALL EXIT
   52 WRITE(IO,503)
      CALL EXIT
   50 WRITE(IO,510) I,XP
      DIV(I) = XP
   30 CONTINUE
      DO 40 I=1,9
```

INCOME GENERATOR PROGRAM
(con't.)

```
   40 INC(I,J)=(DIV(I)+DIV(I+1))/2.DO
C     NEWTON'S METHOD FOR LAST INCOME VALUE Y: F(Y)=.5(1-F(DIV(10)))
      STR=DIV(10) +10.DO
      CALL NEWTON(X,FINC,DERFI,STR,EPS,IEND,IER,DIV(10),A,R)
      IF(IER-1) 60,61,62
   61 WRITE(IO,502) IEND
      CALL EXIT
   62 WRITE(IO,503)
      CALL EXIT
   60 WRITE(IO,511)  X
      INC(10,J)=X
      GO TO 100
  111 DO 112 I=1,10
  112 INC(I,J)=MEDIAN
  100 CONTINUE


      WRITE(6,512)
      WRITE(6,513)   (KK,KK=1,4)
      DO 109 I=1,10
  109 WRITE(6,514)  I,(INC(I,J),J=1,4)
      CALL INTERP(L,INC,YM,YC)
      DO 110 I=1,10
      DO 110 J=1,40
      IF(L.EQ.2)   GO TO 115
      Y(L,I,J) =DMAX1(YM(I,J)      ,0.DO)
      GO TO 110
  115 Y(L,I,J) = DMAX1(YC(I,J)     ,0.DO)
  110 CONTINUE
      IF(L.EQ.2) GO TO 106
      WRITE(6,505)
      GO TO 107
  106 WRITE(6,506)
  107 WRITE(6,507) (KK,KK=1,10)
      DO 108 I=1,40
      II=I+24
  108 WRITE(6,508) II,(Y(L,J,I),J=1,10)
  101 CONTINUE
      WRITE(1)(((Y(I,J,K),K=1,40),J=1,10),I=1,2)
      REWIND 1
      WRITE(6,509)
      CALL EXIT
  500 FORMAT(18A4)
  501 FORMAT('OAGE RANGE',I3,' TO',I3/1X,'MEAN',F10.2,' MEDIAN',F10.2,'
     XSTARTING GUESS FOR R',F10.2)
  502 FORMAT('0 NO CONVERGENCE AFTER',I4,'ITERATIONS. TRY NEW GUESS.')
  503 FORMAT('0 DERIVATIVE= ZERO.     .TRY NEW STARTER.')
  504 FORMAT('0 PARAMETERS: R',D20.10,' A',D20.10)
```

INCOME GENERATOR PROGRAM
(con't.)

```
505 FORMAT('1 INCOME MATRIX FOR MEDICAL GRADS')
506 FORMAT('1 INCOME MATRIX FOR MEDICAL DROPOUTS')
507 FORMAT('0 DECILE',10(6X,I2,4X)/'0 AGE')
508 FORMAT(4X,I2,1X,10F12.2)
509 FORMAT(' INCOME MATRICES ON UNIT 1, 40X10X2')
510 FORMAT('0',I3,' D DIVIDER CALCULATED BY NEWTON''S METHOD =',D20.10
   X)
511 FORMAT('0LAST INCOME VALUE (MEDIAN) BY N. METH. =',D20.10)
512 FORMAT('1 INTERPOLATED INCOME MATRIX')
513 FORMAT('0AGE RANGE ',4(10X,I2,8X)/'0DECILE')
514 FORMAT(I4,6X,4D20.10)
515 FORMAT('1')
    END
    SUBROUTINE INTERP(IFLAG,INC,YM,YC)
    REAL*8 M,B,IST,X,Q,INC(10,4),YM(10,40),YC(10,40)
    DO 100 I=2,4
    DO 100 J=1,10
    M=(INC(J,I)-INC(J,I-1))/10.0D0
    IST=I*10+20
    B=INC(J,I)-M*IST
    III=IST+.4D0-1.0D0
    II=III-9
    IF(I.EQ.2)  II=III-14
    IF(I.EQ.4)     III=IST+.4D0+4.D0
    DO 101 K=II,III
    X=K
    KK=K-24
    Q=M*X+B
C   WRITE(6,500) M,B,Q
C 500 FORMAT(' M=',D20.10,' B=',D20.10,' Q=',D20.10)
    IF(IFLAG.EQ.1) GO TO 102
    YC(J,KK)=Q


    GO TO 101
102 YM(J,KK)=Q
101 CONTINUE
100 CONTINUE
    RETURN
    END
    SUBROUTINE NEWTON (P,FR,DERF,STR,EPS,IEND,IER,MEAN,MEDIAN,Z)
    REAL*8    P,X,A,R,STR,EPS,TOL,TOLF,DP,MEAN,MEDIAN,Q,Z
    DOUBLE PRECISION FR,DERF,DABS,DERF1,FX
    EXTERNAL DERF
    IER=0
    R=STR
    TOL=R
    TOLF=100.0D0*EPS
```

INCOME GENERATOR PROGRAM
(con't.)

```
C     LOOP
      DO 6 I=1,IEND
      IF(FR(MEAN,MEDIAN,R,Z).EQ.0.D0)   GO TO 7
C     NOT SATISFIED FR=0 BY R
    1 IF(DERF(MEAN,MEDIAN,R,Z))  2,8,2
C     ITERATION POSSIBLE
    2 IF(DERF(MEAN,MEDIAN,R,Z).GE.1.D10)   GO TO 10
      DR=FR(MEAN,MEDIAN,R,Z)/DERF(MEAN,MEDIAN,R,Z)
      R=R-DR
      TOL=R
C     ACCURACY CHECK
      TOL=EPS
      Q=DABS(R)
      IF(Q-1.0D0) 4,4,3
    3 TOL=TOL*Q
    4 IF(DABS(DR)-TOL) 5,5,6
    5 IF(DABS(FR(MEAN,MEDIAN,R,Z))-TOLF)7,7,6
    6 CONTINUE
C     END LOOP
C     NO CONVERGENCE
      IER=1
    7 RETURN
C     ZERO DERIV.
    8 IER=2
      RETURN
   10 P=DERF(MEAN,MEDIAN,R,Z)
      WRITE(6,11) P,R
      CALL EXIT
   11 FORMAT('ODERIV. =',D20.10/' X',D20.10)
      END
      DOUBLE PRECISION FUNCTION FR(MEAN,MEDIAN,R,Z)
      REAL*8 MEAN,MEDIAN,R,Z
      FR=R*(MEAN-MEDIAN/(2.0D0**(1.0D0/R)))-MEAN
      RETURN
      END
      DOUBLE PRECISION FUNCTION DERF(MEAN,MEDIAN,R,Z)
      DOUBLE PRECISION DLOG
      REAL*8 MEAN,MEDIAN,R,TWO,A,Z
      TWO=2.0D0**(1.0D0/R)
      DERF=(MEAN-MEDIAN/TWO)-(MEDIAN*DLOG(2.0D0))/(R*TWO)
      RETURN
      END
      DOUBLE PRECISION FUNCTION DERF1(MEAN,A,X,R)
      DOUBLE PRECISION DLOG
      REAL*8 MEAN,MEDIAN,X,A,R
C   1 WRITE(6,3)  R,A,X
      DERF1=(R*(A/X)**(R-1.D0))*(A/(X*X))
C     WRITE(6,4) DERF1
      RETURN
```

INCOME GENERATOR PROGRAM
(concl.)

```
C    4 FORMAT('ODERF1 =',D20.10)
C    3 FORMAT('OP =',D20.10/' A =',D20.10/' X =',D20.10)
       END
       DOUBLE PRECISION FUNCTION FX(A,R,X)
       REAL*8 A,R,X
       IF(X.LT.A) GO TO 100
       FX=-((A/X)**R)
       GO TO 101
  100  FX=0.0D0
  101  CONTINUE
C 101  WRITE(6,102) FX
C 102  FORMAT('OFX=',D20.10)
       RETURN
       END
       DOUBLE PRECISION FUNCTION FA(X,A,XP,R)
       DOUBLE PRECISION FX,X,R,A,XP
       FA=FX(A,R,XP)-FX(A,R,X)-1.D-1
C      WRITE(6,1) FA
C    1 FORMAT('OFA =',D20.10)
       RETURN
       END
       DOUBLE PRECISION FUNCTION FINC(D,A,X,R)
       DOUBLE PRECISION FX,X,A,R,D,FXX,FXDIV
       FINC=FX(A,R,X)+.5D-1
       FXX = FX(A,R,X)
       FXDIV=FX(A,R,D)
C      WRITE(6,1)   X,D,FXX,FXDIV,FINC
C    1 FORMAT('OY=',D20.10,' DIV(10)=',D20.10,' FX(X)=',D20.10,' FX(DIV(1
C     X0))=',D20.10,/'OFINC=',D20.10)
       RETURN
       END
//GO.FT01F001 DD UNIT=DLS,DSN=U.P5103.MEDINC,DISP=(NEW,CATLG,DELETE),
//  SPACE=(TRK,(2,1),RLSE),DCB=(RECFM=VB,BLKSIZE=3204)
//GO.FT01F001 DD DSN=U.P5103.MEDINC,DISP=SHR
//GO.SYSIN DD *
(5X,I2,1X,I2,3F10.0)
       25-34       8990        4811 2.
       35-44      23302       19491 2.
       45-54      25045       20788 2.
       55-64      21499       16949 2.
       25-34       6421        6421 2.
       35-44       8669        8669 2.
       45-54       8949        8949 2.
       55-64       8345        8345 2.
```

INCOME INFLATOR PROGRAM

```
// EXEC WATFIV
//GO.SYSIN DD *
/PROGRAM
      REAL INC(10,40),INTER(10,3)
      READ (5,900) ((INC(I,J),J=6,36,10),I=1,10,1)
  900 FORMAT (4F10.0)
      DO 10 I=1,10
      INTER(I,1)=(INC(I,16)-INC(I, 6))/10.0
      INTER(I,2)=(INC(I,26)-INC(I,16))/10.0
      INTER(I,3)=(INC(I,36)-INC(I,26))/10.0
   10 CONTINUE
      DO 50 I=1,10,1
      DO 20 J=1,5,1
      K=6-J
      INC(I,J)=INC(I,6)-(INTER(I,1)*K)
   20 IF (INC(I,J) .LT. 0.0) INC(I,J)=0.0
      DO 25 J=7,15
      K=J-6
   25 INC(I,J)=INC(I,6)+(INTER(I,1)*K)
      DO 30 J=17,25
      K=J-16
   30 INC(I,J)=INC(I,16)+(INTER(I,2)*K)
      DO 35 J=27,36
      K=J-26
   35 INC(I,J)=INC(I,26)+(INTER(I,3)*K)
      DO 40 J=37,40
      K=J-36
   40 INC(I,J)=INC(I,36)+(INTER(I,3)*K)
   50 CONTINUE
      WRITE (6,905) (J,(INC(I,J),I=1,10),J=1,40)
      BLOW=((1.07)**11)*1.06
      PRINT,BLOW
      DO 55 I=1,10
      DO 55J=1,40
```

INCOME INFLATOR PROGRAM
(concl.)

```
 55 INC(I,J)=INC(I,J)*BLOW
    WRITE (6,905) (J,(INC(I,J),I=1,10),J=1,40)
    DO 80 I=1,10
    INC(I,2)=INC(I,2)*(1.08)
    INC(I,3)=INC(I,3)*(1.08)*(1.07)
    INC(I,4)=INC(I,4)*(1.08)*(1.07)*(1.06)
    BLOW=1.08*1.07*1.06
    PRINT,BLOW
    DO 70 J=5,40
    K=J-4
 70 INC(I,J)=INC(I,J)*BLOW*((1.00)**K)
 80 CONTINUE
    WRITE (6,905) (J,(INC(I,J),I=1,10),J=1,40)
905 FORMAT (' ',40(I3,10(F10.2,2X),/))
    WRITE (7,906) ((INC(I,J),I=1,10,1),J=1,40,1)
906 FORMAT (5F10.0)
    STOP
    END
/GO
3151.     15695.    16640.    13085.
3393.     16300.    17299.    13688.
3688.     17009.    18073.    14404.
4057.     17859.    19002.    15269.
4538.     18908.    20149.    16347.
5194.     20256.    21627.    17749.
6161.     22095.    23647.    19693.
7784.     24874.    26709.    22693.
11389.    30092.    32486.    28520.
22078.    42491.    46300.    42998.
```

APPENDIX F: HOW TO USE CASH-FLOW COMPUTER PROGRAM AND COMPLETE PROGRAM LISTING

This program is constructed to compute cash flow tables for any parameter combination in our "semi-conventional" "fully-contingent" or "partially contingent" student loan programs. It has the capacity to solve for, by an iterative process, several different parameters in each of the three loan programs. This iterative process usually converges rather quickly (2-5 iterations) and is terminated after 60 iterations if a parameter combination is infeasible. The program allows you to "stack" problems in which any input parameter may be varied (including the type of program - semi-conventional, fully or partially contingent).

The program is written in Fortran-IV, requires 60K Bytes of core on an IBM 370/145 and takes approximately .1 to .5 seconds per problem, (depending of course on the parameter choices and number of interations required).

It is strongly suggested that the user examine closely the program listing itself, since the extensive use of comment cards within the program covers the program logical flow more exhaustively than will this documentation.

The required input to the program is very simple: One "data design" card which describes the general design to be in effect for the entire run, one "survival rates" card which adjusts results for deaths of borrowers before the satisfaction of their loan obligation), a series of "income matrix" cards and one or more "problem parameter" cards which set all remaining parameters which are likely to vary from problem to problem. If the user is working with semi-conventional schemes only, income matrices are useless and a program bypass should be inserted to skip the readings of the "income matrix" cards.

The card layout for the data design card is:

```
CC  1-2   IDEC   =  # OF CATEGORIES IMTO WHICH BORROWING COHORT IS DIVIDED
                    (IF USE DECILES, EQUALS 10)

CC  4-9   GRDDEC =  # BORROWERS IN EACH CATEGORY (DECILE) WHICH TAKE OUT
                    EQUAL LOANS FOR THE FULL BORROWING PERIOD (WE USE 9.1,
                    IMPLYING 91 % OF EACH DECILE OF 10 BORROWERS GRADUATE)

CC 11-13 DODEC   =  # BORROWERS IN EACH CATEGORY (DECILE) WHICH TAKE OUT
                    EQUAL LOANS FOR ONLY PART (E.G. 1/2) OF THE BORROWING
                    PERIOD (WE USE .9, IMPLYING A 9 % DROPOUT RATE)

CC 14-15 GRDYR   =  LENGTH OF BORROWING PERIOD FOR "FULL-TERM" BORROWERS
                    (GRADUATES)

CC 16-17 DOYR    =  LENGTH OF BORROWING PERIOD FOR "PARTIAL-TERM" BORROWERS
                    (DROP-OUTS)

CC 18-26 LOANYR  =  LOAN TAKEN OUT PER YEAR ( NOTE THAT BOTH FULL-TERM
                    AND PARTIAL-TERM BORROWERS ARE ASSUMED TO TAKE THE
                    SAME - EQUAL - YEARLY LOANS)

36-38 UPINC   =  # OF YEARS WHICH MUST INFLATE INCOME DATA FOR PARTIAL TERM
                    BORROWERS SO THAT THEIR YEAR 1 INCOME WILL BE CORRECT
                    ( E.G. IF MAKING RUN WHERE THE FIRST INCOME FIGURE INPUT
                    FOR PARTIAL-TERM BORROWERS IS FOR 1970 AND NEED 1973
                    AS YEAR 1 TO BE COMPARABLE TO THE FIRST YEAR OF INCOME
                    DATA INPUT FOR GRADUATES, YOU WOULD SET UPINC TO 3)
                    NOTE : ONCE FULL AND PARTIAL-TERM BORROWERS' INCOME
                    MATRICES ARE EQUIVALENT, CAN THEN INFLATE THEM BOTH
                    PROPERLY

CC 39-41 YRINCG  =  # OF YEARS OF INCOME DATA TO BE INPUT FOR
                    FULL TERM BORROWERS (GRADUATES)

CC 42-44 YRINCD  =  # OF YEARS OF INCOME DATA TO BE INPUT FOR PARTIAL-
                    TERM BORROWERS (DROP-OUTS)
```

DATA DESIGN CARD - continued

CC 45-48 XINFLA = DECIMAL PERCENTAGE BY WHICH BORROWERS INCOMES SHOULD BE INFLATED DURING THE PERIOD SPECIFIED IN UPINC

CC 53-59 CONVG = CONVERGENCE CRITERION : MAXIMUM PERMISSIBLE TOTAL

OUTSTANDING DEBT FOR THE BORROWING COHORT (+/-) - USED TO DETERMINE WHEN TO STOP THE ITERATION

CC 60-64 INFLAT = DECIMAL PERCENTAGE BY WHICH THE CROSS-SECTIONAL INCOME MATRIX WHICH WAS INPUT (AND INCREASED BY XINFLA) MUST BE INFLATED IN ORDER TO GENERATE AN INCOME MATRIX FOR EACH YEAR OVER THEIR REPAYMENT PERIOD - SHOULD BE SET TO ZERO IF WANT INPUT THIS INCOME-OVER-TIME MATRIX DIRECTLY

Special notes on the data design card:

(1) IDEC, GROYR, DOYR are integer variables and thus should be right-justified with no decimal point

(2) All other variables are floating-point (real) and should include decimal points

(3) UPINC will normally be left blank

(4) INFLA also used to inflate full-term borrowers' incomes appropriately over the period where partial-term borrowers have quit borrowing, but full-termers are still going (example - drop-outs borrow 2 years, graduates 4 years, so graduates' incomes must be inflated 2 years to position them 2 years' past the drop-outs)

The card layout for the "survival rates" card is:

CC 1-6 SURRAT(1) = DECIMAL PERCENTAGE OF BORROWERS WHICH ARE ASSUMED TO BE ALIVE (AND THUS ELIGIBLE TO REPAY) THREE YEARS AFTER FULL-TERM BORROWERS QUIT BORROWING (OR FIVE YEARS AFTER PARTIAL-TERM BORROWERS) (E.G. WE USED RATE FOR 30 YEAR OLDS SINCE FULL-TERM BORROWERS ARE ASSUMED TO QUIT BORROWING AT AGE 27)

CC 7-12 SURRAT(2) = DITTO - 8 YEARS AFTER FULL-TERM BORROWERS QUIT BORROWING

CC 13-18 SURRAT(3) = 13 YEARS AFTER

ETC.

CC 49-54 SURRAT(9) = 43 YEARS AFTER

NOTE : IF IGNORING DEATHS , SET ALL THESE TO 1.0

Note that these rates are somewhat specific to our design in that they assume that partial-term borrowers quit borrowing 2 years before full-term borrowers - see GRDPAY and DOPAY computations if want to alter this. If choose to ignore loan defaults by death of borrower, set all these survival rates to 100% (1.0).

The "income matrices" cards have the following format:

(1) Full-term borrowers (GRADS) - Format = (5F10.0) - Thus we had 2 cards for each year of income data (see YRINCG on data design card) Deciles 1-5 on the first card, deciles 6-10 on the second card. Users should probably change format if not working with ten income classes.

(2) Partial-term borrowers (drop-outs) - Format = (8F1D.D) - Since we use equal incomes for all drop-outs within a single year, need input only one income figure for each year. Thus, the incomes for years [illegible] on card 1, incomes for years 9-16 on card 2, etc. For all years of income data being input for drop-outs (=YRINCD on "data design" card) users should change this format and the <u>read</u> statement itself if want to break partial-term borrowers down by income category.

The "problem parameter" card has the following layout:

CC 1-2	GRACE	= GRACE PERIOD ; # OF YEARS AFTER LAST LOAN BEFORE REPAYMENTS MUST BEGIN
CC 4-5	YRPAY	= LENGTH OF REPAYMENT PERIOD (# OF YEARS)
CC 7	IFIXED	= DOES THIS PROBLEM USE A "SEMI-CONVENTIONAL" OR FIXED-REPAYMENT SCHEME ? (YES = 1)
CC 8	ICONT	= DOES THIS PROBLEM USE A "FULLY-CONTINGENT" REPAYMENT SCHEME (YES = 1)
CC 9	IPART	= DOES THIS PROBLEM USE A "PARTIALLY-CONTINGENT" REPAYMENT SCHEME (YES = 1)
CC 10	ITAU	= SOLVE FOR INCOME TAX RATE (TAU) ? (YES = 1)
CC 11	ICOUP	= SOLVE FOR RATE-OF-RETURN IN A FIXED REPAYMENT SCHEDULE ? (YES = 1/2) . (IF EQUALS 1 IN A PARTIALLY CONTINGENT SCHEME , WILL SOLVE FIRST FOR STARTING PAYMENT, THEN FOR COUPON RATE - SEE TABLE BELOW)

PROBLEM PARAMETER CARD - continued

REPAYMENT SCHEME	ITAU	ICOUP	VARIABLE SOLVED FOR
SEMI-CONVENTIONAL	0	0	START
SEMI-CONVENTIONAL	0	2	INRATE (COUPON)
FULLY-CONTINGENT	0	-	INRATE (RETURN)
FULLY-CONTINGENT	1	-	TAU
PARTIALLY-CONTINGENT	0	0	INRATE (RETURN)
PARTIALLY-CONTINGENT	1	-	TAU
PARTIALLY-CONTINGENT	-	1	START-INRATE (COUPON)

CC 15-24 TAU = INITIAL GUESS AT TAX RATE (MEANINGLESS IF IFIXED = 1 , WILL REMAIN AT INITIAL VALUE UNLESS ITAU = 1)

CC 25-34 INRATE = RATE-OF-RETURN (INTEREST RATE) IN ANY OF THE THREE PROGRAMS (IN PARTIALLY CONTINGENT SCHEME WILL EQUAL TOTAL PROGRAM RETURN WHILE SOLVING FOR THE STARTING PAYMENT OF THE FIXED REPAYMENT SCHEDULE , THEN WILL EQUAL THAT PROGRAM'S COUPON RATE AS THE DERIVED STARTING PAYMENT SCHEDULE IS PLUGGED INTO THIS SCHEDULE)

CC 40-45 OPRATE = OPT-OUT RATE ; RATE OF RETURN REQUIRED FROM A BORROWER WHO SATISFIES HIS REPAYMENT OBLIGATION EARLY (BEFORE END OF SPECIFIED REPAYMENT PERIOD) - IN A FULLY CONTINGENT PROGRAM ; NOT USED IN EITHER THE SEMI-CONVENTIONAL OR PARTIALLY CONTINGENT SCHEMES

CC 50-60 START = PAYMENT MADE IN THE FIRST YEAR OF THE REPAYMENT PERIOD BY ALL FULL-TERM BORROWERS (I.E. GRADUATES ; DROP-OUTS PAY HALF OF THIS SINCE ONLY BORROWED HALF AS MUCH) NOT USED IN FULLY- CONTINGENT PROGRAM

CC 65-70 GROW = ANNUAL DECIMAL PERCENTAGE GROWTH OF PAYMENTS IN FIXED REPAYMENT SCHEDULE (IN SEMI-CONVENTIONAL SCHEME OR AS ONE OPTION OF PARTIALLY CONTINGENT PROGRAM)

CC 71 IADV = MARKER FOR PRESENCE OF ADVERSE SELECTION CARD (T = YES, F = NO).

CC 72 PRTINC = DO YOU WANT INCOME MATRICES PRINTED ? (YES = 1)

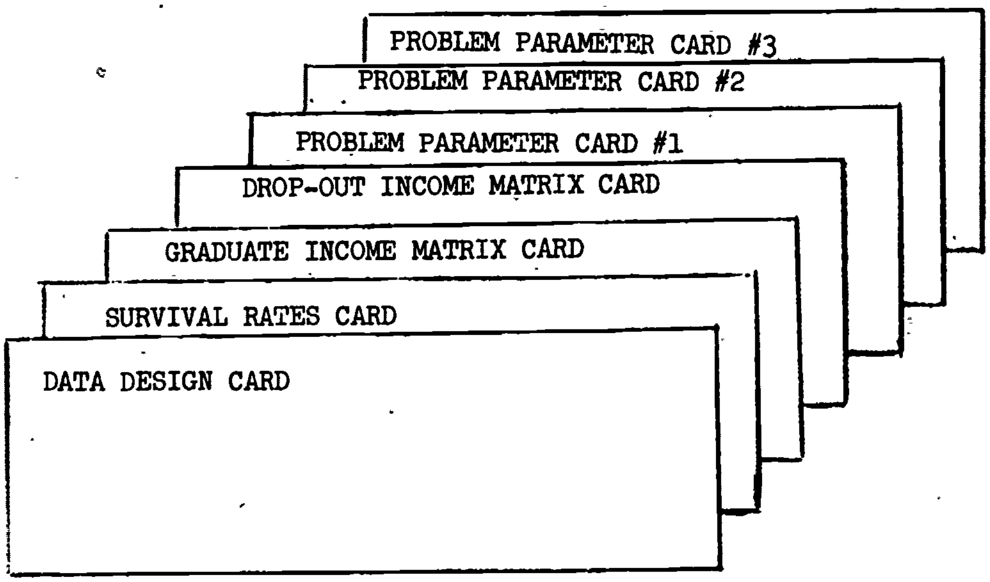
CC 73 ISTOP = STOP ITERATIVE PROCESS AFTER FIRST CASH FLOW COMPUTED ? (YES = 1)

CC 74 PRTDEC = DO YOU WANT CASH FLOWS PRINTED FOR ALL DECILES ? (NO [redacted]=1)

COMPLETE PROGRAM LISTING

```
C   THIS PROGRAM MAY BE USED TO GENERATE THE CASH FLOWS WHICH RESULT FROM
C  VARIOUS ASSUMPTIONS ABOUT THE FINANCIAL ENVIRONMENT, STUDENT PARTICIPATION,
C  ETC. ENCOUNTERED IN A MEDICAL STUDENT FINANCIAL AID PROGRAM. THE PROGRAM ALSO
C  HAS THE ABILITY TO VARY ONE PARAMETER, HOLDING ALL OTHERS CONSTANT ,
C  UNTIL THE AID PROGRAM IS VIABLE , I.E. " BREAKS EVEN " IN THE SPECIFIED
C  TIME PERIOD. THE PROGRAM IS CAPABLE OF WORKING WITH THREE DIFFERENT LOAN
C  SCHEMES :  (1) A SEMI-CONVENTIONAL SCHEME WHERE REPAYMENTS GROW AT A
C  SPECIFIED CONSTANT RATE OVER THE REPAYMENT PERIOD ,  (2) A SCHEME WHERE
C  REPAYMENTS ARE DETERMINED SOLELY BY APPLYING A CONSTANT TAX RATE TO THE
C  BORROWERS INCOME OVER THE REPAYMENT PERIOD , AND (3) A SCHEME OF PARTIAL
C  CONTINGENCY,WHERE EACH BORROWER REPAYS EACH YEAR EITHER THAT AMOUNT REQUIRED
C  IN (1) OR THAT REQUIRED IN (2) , WHICHEVER AMOUNT IS LOWER .
C
C    IF ITERATION IS DESIRED THE USER WILL SOLVE FOR THE FOLLOWING PARAMETERS :
C
C   (1) CONVENTIONAL SCHEME - (A) SOLVES FOR THE INITIAL PAYMENT, TO WHICH THE
C  GROWTH RATE MAY BE APPLIED TO GENERATE THE TOTAL SERIES OF REPAYMENTS
C  OR (B) SOLVES FOR THE INTEREST RATE IMPLICIT IN A GIVEN STARTING PAYMENT
C  AND GROWTH RATE OF REPAYMENTS
C
C   (2) FULLY CONTINGENT SCHEME - (A) SOLVES FOR THE TAX RATE WHICH IS NECESSARY
C  TO ACHIEVE THE DESIRED RETURN OR (B) THE INTEREST RATE WHICH CAN BE CHARGED,
C  REPAYMENTS GIVEN A TAX RATE
C
C   (3) PARTIALLY CONTINGENT SCHEME
C
C     (A) SOLVE FOR THE RETURN GENERATED,GIVEN A TAX RATE AND A CONVENTIONAL
C  REPAYMENT SCHEDULE
C
C     (B) SOLVE FOR THE TAX RATE NECESSARY TO ACHIEVE THE GIVEN RETURN , GIVEN A
C  CONVENTIONAL REPAYMENT SCHEDULE .
C
C     (C) SOLVE FOR THE STARTING PAYMENT OF THE FIXED-REPAYMENT SCHEDULE,
C  THEN FOR THE INTEREST RATE IMPLICIT IN THAT SCHEDULE
C
C  THIS PROGRAM WOULD BE EASILY ADAPTIBLE TO ITERATIONS OF DIFFERENT PARAMETERS
C
C PROGRAM VARIABLES:
C
C A. FINANCIAL-AID PROGRAM KEYS:
C
C    1. CONVENTIONAL
C        A. ITERATING FOR STARTING PAYMENT - SET IFIXED=1,ICONT=0,IPART=0,
C           ITAU=0,ICOUP=0
C        B. ITERATING FOR RETURN - SET IFIXED=1,ICONT=0,IPART=0,ITAU=0,ICOUP=2
C    2. FULLY CONTINGENT
C        A. ITERATING FOR RETURN - SET ICONT=1,IFIXED=0,IPART=0,ITAU=0,ICOUP=0
C        B. ITERATING FOR TAX RATE - SET ICONT=1,IFIXED=0,IPART=0,ITAU=1,ICOUP=0
C    3. PARTIALLY CONTINGENT
C        A. ITERATING FOR RETURN - SET IPART=1,IFIXED=0,ICONT=0,ITAU=0,ICOUP=0
C        B. ITERATING FOR TAX RATE - SET IPART=1,ITAU=1,ICONT=0,IFIXED=0,ICOUP=0
C        C. ITERATING FOR STARTING PAYMENT (AND COUPON RATE) - SET IPART=1,
C           ICONT=0,IFIXED=0,ITAU=0,ICOUP=1
C B. INPUT PARAMETERS FOR DATA DESIGN - SEE BELOW
C
C
C C. INCOME DATA (INPUT VIA DATA CARDS)
```

A sample input deck for a run with 3 problems might be:



```
C
C     1. DOINC - INCOME BY DECILE FOR DROPOUTS FROM AGE 25 TO 64 (1970-2010)
C     2. GRDINC -INCOME BY DECILE FOR GRADUATES FOM AGE 27 TO 64 (1970-2008)
C
C D. REPAYMENT VARIABLES :
C
C     1. DCONT - INTERMEDIATE VARIABLE WHICH SPECIFIES A REPAYMENT REQUIRED
C        FROM A DROPOUT UNDER CONTINGENCY OPTION
C     2. DFIXED - INTERMEDIATE VARIABLE WHICH SPECIFIES A REPAYMENT REQUIRED
C        FROM A DROPOUT UNDER CONVENTIONAL REPAYMENT SCHEME
C     3. DOPAY - FINAL PAYMENT ARRAY CONTAINING ACTUAL REPAYMENTS TO BE MADE
C        BY DROPOUTS IN EACH OF THE TEN DECILES IN EACH OF THE YEARS OF THE AID
C        PROGRAM
C     4. GCONT - SEE DCONT (GRADUATES)
C     5. GFIXED - SEE DFIXED (GRADUATES)
C     6. GRDPAY - SEE DOPAY (GRADUATES)
C
C E. CASH-FLOW VARIABLES
C
C     1. CFLOW - TOTAL CASH FLOW (REPAYMENTS LESS NEW LOANS AND INTEREST DUE) FOR
C        YEAR
C     2. INTDUE - INTEREST DUE AT THE END OF THE YEAR ON PAST LOANS, PRESENT LOAN
C        AND PAST BORROWINGS TO MEET INTEREST CHARGES
C     3. LOAN - LOAN EXTENDED AT THE BEGINNING OF THE YEAR
C     4. OSDEBT - OUTSTANDING DEBT AT THE END OF THE YEAR
C     5. PRINPD - THAT PORTION OF YEARS REPAYMENTS WHICH ARE APPLIED TO THE
C        OUTSTANDING PRINCIPAL OF THE LOAN.
C     6. REPAY - REPAYMENTS MADE AT THE END OF THE YEAR
C     7. TOTLON - TOTAL LOANS EXTENDED (PAST AND PRESENT)
C     8. TOTPPD - TOTAL PRINCIPAL PAID IN PAST YEARS (DEDUCTED FROM LOANS TO GET
C        BASE ON WHICH INTEREST MUST BE CHARGED)
C
C F. MISCELLANEOUS VARIABLES :
C
C     1. BORR - TOTAL # OF BORROWERS (GRADUATES AND DROPOUTS) PARTICIPATING IN
C        LOAN PROGRAM
C     2. DEATHD,DEATHG - CUMULATIVE # OF DEATHS FOR EACH YEAR AFTER REPAYMENTS
C        BEGIN FOR DROPOUTS AND GRADUATES
C     3. ENDPAY (=LAST) - LAST YEAR THAT REPAYMENTS WILL APPLIED TO CASH FLOW
C        CALCULATIONS
C     4. IMARK,JMARK - ARRAYS WHICH KEEP TRACK OF WHICH DECILES EXERCISE
C        CONTINGENCY OPTION IN THE PARTIALLY CONTINGENT REPAYMENT SCHEME (FOR
C        GRADUATES AND DROPOUTS)
C     5. LASTD - LAST YEAR OF REPAYMENTS FOR DROPOUTS
C     6. LASTG - LAST YEAR OF REPAYMENTS FOR GRADUATES
C     7. OP - OPT-OUT RATE EXPRESSED AS A PERCENT
C     8. OPYEAR - YEAR IN WHICH EACH GRADUATE DECILE OPTS OUT
C     9. REQRT - INTEREST RATE (RETURN) EXPRESSED AS A PERCENT
C    10. SAVE - THE FINAL OUTSTANDING DEBT RESULTING FROM THE PREVIOUS ITERATION
C    11. SURVD,SURVG - INTERMEDIATE VARIABLES INDICATING # OF SURVIVORS
C        AT BEGINNING OF EACH OF THE FIVE YEAR "DEATH PERIODS" - USED AS
C        BASE ON WHICH DEATH RATES ARE APPLIED
C    12. XGROW - GROWTH RATE OF CONVENTIONAL REPAYMENT SCHEDULE EXPRESSED AS A
C        PERCENT
      DIMENSION SIN(2),SST(2),STAU(2)
      REAL   LOANYR,INRATE,LOAN(40),INTDUE(40),INFLAT
      INTEGER GROUP(10),OCCP(10),PRTINC,PRTDEC
      INTEGER GRACE,YRPAY,OPYEAR(10),ENDPAY,UPINC,GRAC
      INTEGER GRDYR,DOYR,YRINCG,YRINCD
      DIMENSION GRDINC(10,40),DOINC(10,40),GRDPAY(10,40),DOPAY(10,40),
     1 REPAY(40),PRINPD(40),CFLOW(40),OSDEBT(40)
      DIMENSION SURRAT(9),DEATHG(40),DEATHD(40)
      DIMENSION TEMP(5,25)
```

```
      DIMENSION IMARK(10,40)
      DIMENSION JMARK(10,40)
      DIMENSION W(10)
      LOGICAL IADV
C
C     DATA DESIGN CARD
C
C     CC  1-2  IDEC   =  # OF CATEGORIES IMTO WHICH BORROWING COHORT IS DIVIDED
C                        (IF USE DECILES, EQUALS 10)
C
C     CC  4-9  GRDDEC =  # BORROWERS IN EACH CATEGORY (DECILE) WHICH TAKE OUT
C                        EQUAL LOANS FOR THE FULL BORROWING PERIOD (WE USE 9.1,
C                        IMPLYING 91 % OF EACH DECILE OF 10 BORROWERS GRADUATE)
C
C     CC 11-13 DODEC  =  # BORROWERS IN EACH CATEGORY (DECILE) WHICH TAKE OUT
C                        EQUAL LOANS FOR ONLY PART (E.G. 1/2) OF THE BORROWING
C                        PERIOD (WE USE .9, IMPLYING A 9 % DROPOUT RATE)
C
C     CC 14-15 GRDYR  =  LENGTH OF BORROWING PERIOD FOR "FULL-TERM" BORROWERS
C                        (GRADUATES)
C
C     CC 16-17 DOYR   =  LENGTH OF BORROWING PERIOD FOR "PARTIAL-TERM" BORROWERS
C                        (DROP-OUTS)
C
C     CC 18-26 LOANYR =  LOAN TAKEN OUT PER YEAR ( NOTE THAT BOTH FULL-TERM
C                        AND PARTIAL-TERM BORROWERS ARE ASSUMED TO TAKE THE
C                        SAME - EQUAL - YEARLY LOANS)
C
C     36-38 UPINC   = # OF YEARS WHICH MUST INFLATE INCOME DATA FOR PARTIAL TERM
C                        BORROWERS SO THAT THEIR YEAR 1 INCOME WILL BE CORRECT
C                        ( E.G. IF MAKING RUN WHERE THE FIRST INCOME FIGURE INPUT
C                        FOR PARTIAL-TERM BORROWERS IS FOR 1970 AND NEED 1973
C                        AS YEAR 1 TO BE COMPARABLE TO THE FIRST YEAR OF INCOME
C                        DATA INPUT FOR GRADUATES, YOU WOULD SET UPINC TO 3)
C                        NOTE : ONCE FULL AND PARTIAL-TERM BORROWERS' INCOME
C                        MATRICES ARE EQUIVALENT, CAN THEN INFLATE THEM BOTH
C                        PROPERLY
C
C     CC 39-41 YRINCG =  # OF YEARS OF INCOME DATA TO BE INPUT FOR
C                        FULL TERM BORROWERS (GRADUATES)
C
C     CC 42-44 YRINCD =  # OF YEARS OF INCOME DATA TO BE INPUT FOR PARTIAL-
C                        TERM BORROWERS (DROP-OUTS)
C
C     CC 45-48 XINFLA =  DECIMAL PERCENTAGE BY WHICH BORROWERS INCOMES SHOULD
C                        BE INFLATED DURING THE PERIOD SPECIFIED IN UPINC
C
C     CC 53-59 CONVG  =  CONVERGENCE CRITERION : MAXIMUM PERMISSIBLE TOTAL
C                        OUTSTANDING DEBT FOR THE BORROWING COHORT (+/-0 - USED T
C                        OUTSTANDING DEBT FOR THE BORROWING COHORT (+/-) - USED
C                        TO DETERMINE WHEN TO STOP THE ITERATION
C
C     CC 60-64 INFLAT =  DECIMAL PERCENTAGE BY WHICH THE CROSS-SECTIONAL INCOME
C                        MATRIX WHICH WAS INPUT (AND INCREASED BY XINFLA) MUST
C                        BE INFLATED IN ORDER TO GENERATE AN INCOME MATRIX FOR
C                        EACH YEAR OVER THEIR REPAYMENT PERIOD - SHOULD BE SET TO
C                        ZERO IF WANT INPUT THIS INCOME-OVER-TIME MATRIX DIRECTLY
C
C
C
C
C     SURVIVAL RATES CARD
C
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C
C     CC  1-6  SURRAT(1) = DECIMAL PERCENTAFE OF BORROWERS WHICH ARE ASSUMED TO
C                          BE ALIVE  (AND THUS ELIGIBLE TO REPAY) THREE YEARS
C                          AFTER FULL-TERM BORROWERS QUIT BORROWING (OR FIVE
C                          YEARS AFTER PARTIAL-TERM BORROWERS) (E.G. WE USED
C                          RATE FOR 30 YEAR OLDS SINCE FULL-TERM BORROWERS ARE
C                          ASSUMED TO QUIT BORROWING AT AGE 27)
C
C     CC  7-12 SURRAT(2) = DITTO - 8 YEARS AFTER FULL-TERM BORROWERS QUIT
C                          BORROWING
C
C     CC 13-18 SURRAT(3) = 13 YEARS AFTER
C
C                          ETC.
C
C     CC 49-54 SURRAT(9) = 43 YEARS AFTER
C
C     NOTE : IF IGNORING DEATHS , SET ALL THESE TO 1.0
C
      READ (5,991) IDEC,GRDDEC,DODEC,GRDYR,DOYR,LOANYR,UPINC,
     1  YRINCG,YRINCD,XINFLA,CONVG,INFLAT,INCYR,(SURRAT(I),I=1,9)
  991 FORMAT (I2,1X,F6.0,1X,F3.0,2I2,F9.0,9X,3I3,F4.0,4X,F7.0,F5.0,I4,/,
     1 9F6.0)
C     FILL FULL-TERM BORROWERS (GRADUATES) INCOME MATRIX - EXPECTS INCOME
C     DATA FOR ALL (IDEC) CATEGORIES WITHIN EACH YEAR ( NOTE : MAY BE CROSS-
C     SECTIONAL OR "OVER TIME", DEPENDING ON VALUE OF INFLAT
C AGE 27 ON (BEGINS WITH YEAR FOLLOWING GRADUATION)
C
      READ (5,800) ((GRDINC(I,J),I=1,IDEC),J=1,YRINCG)
      IF (YRINCD .EQ. 0) GO TO 666
C
C     FILL PARTIAL-TERM BORROWERS (DROP-OUTS) INCOME MATRIX
C AGE 25 ON (BEGINS WITH YEAR FOLLOWING DROPPING OUT)
C
      READ (5,801) (DCINC(1,J),J=1,YRINCD)
C
C     NOTE : THESE TWO MATRICES WILL BE USED BY ALL PROBLEMS WITHIN THIS RUN
C
C
C     BORR : TOTAL NUMBER OF BORROWERS (FULL-TERM AND PARTIAL-TERM --GRADUATES
C               AND DROP-OUTS) IN THIS SET OF PROBLEMS
C
C
C
C  NOTE ON INCOMES -- PROGRAM READS INCOMES OVER TIME FOR BOTH GRADUATES AND
C  DROPOUTS AS OF 1970. IF YOU INFLATE GRADUATES' INCOMES FOR TWO YEARS, YOU
C  HAVE APPROPRIATE INCOME DATA FOR A CLASS WHICH ENTERS IN 1969 WHERE DROPOUTS
C  BEGIN REPAYMENTS IN 1971 (BASED ON 1970 INCOMES) AND GRADUATES BEGIN
C  REPAYMENTS IN 1973 (BASED ON 1972 INCOMES). FOR A CLASS ENTERING IN 1972,
C  THE VARIABLE UPINC SHOULD BE SET EQUAL TO 3, TO INFLATE THE INCOMES PROPERLY.
C
C     PARTIAL TERM BORROWERS ARE ASSUMED TO HAVE EQUAL INCOMES WITHIN A GIVEN
C     AGE BRACKET - NO DIFFERENTIATION BY CATEGORY (DECILE)
C
      IF (DODEC .EQ. 0) GO TO 3
      DO 4 I=2,IDEC
      DO 4 J=1,YRINCD
      DCINC(I,J)=DCINC(1,J)
    4 CONTINUE
C
C     INFLATE PARTIAL TERM BORROWERS' INCOMES
C
      DO 505 I=1,IDEC
```

```
      DO 505 J=1,YRINCD
      DOINC(I,J)=DOINC(I,J)*((1.0+XINFLA)** UPINC)
  505 CONTINUE
    3 CONTINUE
C INCOME OVER TIME FOR DROPOUTS BEGINNING IN 1970 + VALUE OF UPINC
C
      IF (INFLAT .EQ. 0) GO TO 666
      DO 665 I=1,IDEC
      DO 665 J=1,YRINCD
  665 DOINC(I,J)=DOINC(I,J)*((1.0+INFLAT)**(J-1))
  666 CONTINUE
C INCOME FOR GRADUATING CLASS BEGINNING IN 1972 + VALUE OF UPINC
C
      DO 5 I=1,IDEC
      DO 5 J=1,YRINCG
      GRDINC (I,J)=GRDINC(I,J)*((1.0+XINFLA)**(UPINC+GRDYR-DOYR))
    5 CONTINUE
C
C     IF CROSS-SECTIONAL DATA HAS BEEN INPUT ( INFLAT > 0), INFLATE TO INCOMES
C     OVER TIME
C
      IF (INFLAT .EQ. 0) GO TO 667
      DO 6 I=1,IDEC
      DO 6 J=1,YRINCG
    6 GRDINC(I,J)=GRDINC(I,J)*((1.0+INFLAT)**(J-1))
  667 CONTINUE
C
C     COMPUTE NUMBER OF DEATHS FOR EACH OF 40 POSSIBLE REPAYMENT YEARS
C     (FOR US , AGES 25-64 )
C
C
C     # SURVIVORS ( INITIALIZED TO # OF BORROWERS BEGINNING - BOTH FULL-TERM
C     AND PARTIAL TERM )
C
      SURVG=GRDDEC
      SURVD=DODEC
      DO 8 I=1,8
      M=I*5
      N=M-4
      DO 7 J=N,M
      DEATHG(J)=(.2)*(1.0-SURRAT(I))*SURVG
      DEATHD(J)=(.2)*(1.0-SURRAT(I))*SURVD
    7 CONTINUE
C
C     SINCE SURVIVAL RATES GIVEN IN FIVE YEAR INTERVALS ( I.E. SURVIVAL RATE # 1
C     IS GIVEN AS A PERCENTAGE OF THOSE LIVING IN YEAR 1, SURVIVAL RATE AS A %
C     OF THOSE LIVING IN YEAR 5 ) , MUST CONTINUALLY UPDATE SURVIVORS BEFORE
C     COMPUTING DEATHS FOR NEXT 5 YEARS
C
      SURVG=SURVG-(DEATHG(I*5)*5)
      SURVD=SURVD-(DEATHD(I*5)*5)
    8 CONTINUE
C
C     CONVERT DEATH ARRAY TO A CUMULATIVE DEATH COUNT
C
      DO 9 I=2,40
      DEATHG(I)=DEATHG(I)+DEATHG(I-1)
      DEATHD(I)=DEATHD(I)+DEATHD(I-1)
    9 CONTINUE
  919 NUM=0
C
```

```
C      PROBLEM PARAMETER CARD :
C
C      CC  1-2  GRACE  = GRACE PERIOD ; # OF YEARS AFTER LAST LOAN BEFORE
C                        REPAYMENTS MUST BEGIN
C
C      CC  4-5  YRPAY  = LENGTH OF REPAYMENT PERIOD ( # OF YEARS )
C
C      CC  7    IFIXEL = DOES THIS PROBLEM USE A "SEMI-CONVENTIONAL" OR FIXED-
C                        REPAYMENT SCHEME ? ( YES = 1 )
C
C      CC  8    ICONT =  DOES THIS PROBLEM USE A "FULLY-CONTINGENT" REPAYMENT
C                        SCHEME ( YES = 1 )
C
C      CC  9    IPART  = DOES THIS PROBLEM USE A "PARTIALLY-CONTINGENT" REPAYMENT
C                        SCHEME ( YES = 1)
C
C      CC 10    ITAU   = SOLVE FOR INCOME TAX RATE ( TAU ) ? ( YES = 1 )
C
C      CC 11    ICOUP  = SOLVE FOR RATE-OF-RETURN IN A FIXED REPAYMENT SCHEDULE ?
C                        ( YES  = 1/2)  (IF EQUALS 1 IN A PARTIALLY CONTINGENT
C                        SCHEME , WILL SOLVE FIRST FOR STARTING PAYMENT, THEN FOR
C                        COUPON RATE - SEE TABLE BELOW )
C
C                   REPAYMENT SCHEME    ITAU  ICOUP  VARIABLE SOLVED FOR
C*****************************************************************************
C                   SEMI-CONVENTIONAL    0      0         START
C                   SEMI-CONVENTIONAL    0      2     INRATE (COUPON)
C                   FULLY-CONTINGENT     0      -     INRATE (RETURN)
C                   FULLY-CONTINGENT     1      -          TAU
C                   PARTIALLY-CONTINGENT 0      0     INRATE (RETURN)
C                   PARTIALLY-CONTINGENT 1      -          TAU
C                   PARTIALLY-CONTINGENT -      1   START-INRATE (COUPON)
C
C
C      CC 15-24 TAU    = INITIAL GUESS AT TAX RATE ( MEANINGLESS IF IFIXED = 1 ,
C                       WILL REMAIN AT INITIAL VALUE UNLESS ITAU = 1 )
C
C      CC 25-34 INRATE = RATE-OF-RETURN ( INTEREST RATE ) IN ANY OF THE THREE
C                        PROGRAMS ( IN PARTIALLY CONTINGENT SCHEME WILL EQUAL
C                        TOTAL PROGRAM RETURN WHILE SOLVING FOR THE STARTING
C                        PAYMENT OF THE FIXED REPAYMENT SCHEDULE , THEN WILL
C                        EQUAL THAT PROGRAM'S COUPON RATE AS THE DERIVED STARTING
C                        PAYMENT SCHEDULE IS PLUGGED INTO THIS SCHEDULE )
C
C      CC 40-45 OPRATE = OPT-OUT RATE ; RATE OF RETURN REQUIRED FROM A BORROWER
C                        WHO SATISFIES HIS REPAYMENT OBLIGATION EARLY
C                        ( BEFORE END OF SPECIFIED REPAYMENT PERIOD ) - IN A
C                        FULLY CONTINGENT PROGRAM ; NOT USED IN EITHER THE SEMI-
C                        CONVENTIONAL OR PARTIALLY CONTINGENT SCHEMES
C
C      CC 50-60 START  = PAYMENT MADE IN THE FIRST YEAR OF THE REPAYMENT PERIOD
C                        BY ALL FULL-TERM BORROWERS ( I.E. GRADUATES ; DROP-OUTS
C                        PAY HALF OF THIS SINCE ONLY BORROWED HALF AS MUCH )
C                        NOT USED IN FULLY- CONTINGENT PROGRAM
C
C
C      CC 65-71 GROW   = ANNUAL DECIMAL PERCENTAGE GROWTH OF PAYMENTS IN
C                        FIXED REPAYMENT SCHEDULE (IN SEMI-CONVENTIONAL SCHEME OR
C                        AS ONE OPTION OF PARTIALLY CONTINGENT PROGRAM)
C      CC 72    IADV   = MARKER FOR PRESENCE OF ADVERSE SELECTION CARD
C                        (T = YES, F = NO )
C
C      CC 73    PRTINC = DO YOU WANT INCOME MATRICES PRINTED ? ( YES = 1 )
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```
C
C     CC 75     ISTOP   = STOP ITERATIVE PROCESS AFTER FIRST CASH FLOW COMPUTED ?
C                         ( YES = 1)
C
C     CC 74     PRTDEC = DO YOU WANT CASH FLOWS PRINTED FOR ALL DECILES ? (YES=1)
C
      READ (5,988,END=989) GRACE,YRPAY,IFIXED,ICONT,IPART,ITAU,ICOUP,
     XTAU,INRATE,OPRATE,START,GROW,IADV
     X,PRTINC,ISTOP,PRTDEC
  988 FORMAT (I2,1X,I2,1X,4I1,I1,   3X,2F10.0,5X,F6.0,4X,F11.0,4X,F6.0,
     X L1,3I1)
C     CC 73     W       = DECIMAL PERCENTAGE OF EACH DECILE WHICH IS PARTICIPATING
C                         IN PROGRAM ; INITIALIZE TO 100 % , CHANGE BY ADVERSE
C                         SELECTION CARD (READ IF IADV = " TRUE " )
C
      DO 1000 I=1,IDEC
 1000 W(I)=1.
C     ADVERSE SELECTION CARD
C
C
C     CC  1-8  W(1)    = PROPORTION OF DECILE 1 PARTICIPATING IN PROGRAM
C                        ( APPLIES TO BOTH FULL AND PARTIAL-TERM BORROWERS )
C
C     CC  9-16 W(2)    = DECILE (2)
C
C     CC 73-80 W(10)   = DECILE (10)
C
      IF(IADV)   READ 1006,W
 1006 FORMAT(10F8.0)
C
C     SW = TOTAL FRACTION OF THE BORROWING COHORT ((GRDDEC+DODEC)*10) PARTICI-
C          PATING IN PROGRAM ; USED LATER TO COMPUTE TOTAL LOANS EXTENDED TO
C          BORROWING COHORT
C
 1005 SW=0.
      DO 1002 I=1,IDEC
 1002 SW=SW+W(I)
      BORR=(GRDDEC+DODEC)*SW
C     LAST = LAST YEAR OF REPAYMENTS BY BORROWIMG COHORT
C
      LAST=GRDYR+GRACE+YRPAY
C
C     LASTD = LAST YEAR OF REPAYMENTS BY PARTIAL-TERM BORROWERS (DROPOUTS)
C
      LASTD=DOYR+GRACE+YRPAY
C
C     LASTG = LAST YEAR OF REPAYMENTS BY FULL-TERM BORROWERS (GRADUATES)
C
      LASTG=LAST
C
C     XGROW = % GROWTH OF PAYMENTS IN FIXED REPAYMENT SCHEDULE (FOR PRINTING
C             PURPOSES)
C
      XGROW=GROW*100.0
C
C     OP = % OPT-OUT RATE (FOR PRINTING PURPOSES )
C
      OP=OPRATE*100.0
      TAU=TAU*((LOANYR*GRDYR)/1000.)
      M=1+GRACE
      N=1+GRACE
      MM=LASTG-GRDYR
      NN=LASTD-DOYR
```

```
      JYEAR=1970+UPINC
C
C     PRINT INCOME MATRICES IF DESIRED (PRINTS ONLY THOSE INCOMES USED IN
C     COMPUTING REPAYMENTS, I.E. ONLY FOR THE YEARS WHICH ACTUALLY FALL WITHIN
C     THE REPAYMENT YEARS )
C
      IF(PRTINC.EQ.1)WRITE (6,904) JYEAR,((GRDINC(I,J),I=1,IDEC),J=M,MM)
      JYEAR=1972+UPINC
      IF(PRTINC.EQ.1)WRITE (6,904) JYEAR,((DOINC(I,J),I=1,IDEC),J=N,NN)
   21 CONTINUE
C
C     REQRT = % INTEREST RATE (FOR PRINTING PURPOSES)
C
      REQRT=INRATE*100.0
C
C CALCULATE REPAYMENT SCHEDULES FOR ALL DECILES OF GRADUATES AND DROPOUTS
C
      DO 20 I=1,IDEC
      DO 10 J=1,40
      GRDPAY(I,J)=0.0
       DOPAY(I,J)=0.0
      LOAN(J)=0.0
      JMARK(I,J)=0
      IMARK(I,J)=0
   10 CONTINUE
C
C   TOTAL PAYMENTS FOR DECILE UNDER CONTINGENT SCHEME EQUAL AVERAGE INCOME *
C   TAX RATE * #   OF PARTICIPANTS IN THE DECILE
C
      M=GRDYR+GRACE+1
      N=DOYR+GRACE+1
      DO 19 J=M,LASTG
      K=J-GRDYR
      GCONT=GRDINC(I,K)*((GRDDEC-DEATHG(K+2))*W(I))*TAU
      GFIXED=START*((1.0+GROW)**(J-M))*((GRDDEC-DEATHG(K+2))*W(I))
      IF (ICONT .EQ. 1) GRDPAY(I,J)=GCONT
      IF (IFIXED .EQ. 1) GRDPAY(I,J)=GFIXED
      IF ( IPART .EQ. 1) GRDPAY(I,J)=AMIN1(GCONT,GFIXED)
C
C   UNDER PARTIAL CONTINGENCY, KEEP TRACK OF THOSE WHICH EXERCISE THE CONTINGENCY
C   FOR USE IN LATER PRINTING
C
      IF (IPART .EQ. 1 .AND. GRDPAY(I,J) .EQ. GCONT) IMARK(I,J)=1
   19 CONTINUE
      IF (DODEC .EQ. 0) GO TO 20
      DO 22 J=N,LASTD
      K=J-DOYR
      DCONT=DOINC(I,K)*(((DODEC)-DEATHD(K))*W(I))*(TAU/2.0)
      DFIXED=(START/2.0)*((1.0+GROW)**(J-N))*(((DODEC)-DEATHD(K)
     X)*W(I))
      IF (ICONT .EQ. 1) DOPAY(I,J)=DCONT
      IF (IFIXED .EQ. 1) DOPAY(I,J)=DFIXED
      IF (IPART .EQ. 1) DOPAY(I,J)=AMIN1(DCONT,DFIXED)
      IF (IPART .EQ. 1 .AND. DOPAY(I,J) .EQ. DCONT) JMARK(I,J)=1
   22 CONTINUE
   20 CONTINUE
C
C     IF FULLY CONTINGENT PROGRAM , MUST ADJUST REPAYMENT SCHEDULE FOR ALL
C     DECILES WHICH EXERCISE THE OPT-OUT FEATURE ; TO DO THIS WE CALL CASH
C     FLOW SUBROUTINE TEN TIMES (ASSUMING NUMBER OF CATEGORIES = 10), USING THE
C     OPT-OUT RATE AS THE REQUIRED RETURN ; THEN THE OPT-OUT YEAR WILL BE THE
C     FIRST YEAR WITH A NEGATIVE OUTSTANDING DEBT (INDICATING OVERPAYMENT, AT
C     AN INTEREST RATE EQUAL TO THE OPT-OUT RATE )
```

```
C
      IF (ICONT .NE. 1) GO TO 51
      DO 90 M=1,2
      IF (DODEC .EQ. 0 .AND. M .EQ. 2) GO TO 51
      DO 50 I=1,IDEC
      IF (M .EQ. 2 .AND. I .EQ. 2) GO TO 90
C
C  NEED CONSIDER ONLY ONE DECILE UNDER FIXED REPAYMENT PROGRAM SINCE ALL
C  DECILES HAVE EQUAL INCOMES AND THUS EQUIVALENT REPAYMENT SCHEDULES
C
C
      DO 23 J=1,40
      REPAY(J)=0.0
   23 CONTINUE
      DO 25 J=1,LAST
      LOAN(J)=0.0
      IF (M .EQ. 1) REPAY(J)=GRDPAY(I,J)
      IF (M .EQ. 2) REPAY(J)= DOPAY(I,J)
   25 CONTINUE
      IF (M .EQ. 2) GO TO 180
      DO 1001 MMM=1,GRDYR
 1001 LOAN(MMM)=LOANYR*GRDDEC*W(I)
      GO TO 181
  180 CONTINUE
      DO 179 MMM=1,DOYR
  179 LOAN(MMM)=LOANYR*DODEC*W(I)
  181 CONTINUE
C
C NOTE THAT SEND OPT/OUT RATE INSTEAD OF INTEREST RATE
C
      CALL CSHFLO(REPAY,YRPAY,GRACE,OPRATE,LOAN,INTDUE,PRINPD,OSDEBT,
     1  CFLOW,GRDYR)
C
C DETERMINATION OF OPT-OUT YEARS FOR EACH GRADUATE DECILE
C
      IF (M .EQ. 1) GRDOP(I)=LAST
      IF (M .EQ. 2)  DOOP(I)=LAST
      OPYEAR(I)=      YRPAY
      L=OPYEAR(I)
C
C IF POSITIVE ENDING BALANCE, NO OVERPAYMENT AND THUS NO OPTING-OUT
C
      IF (OSDEBT(LAST) .GE. 0.0) GO TO 41
C
C FIND THE LAST YEAR OF REPAYMENT WITH A POSITIVE ENDING BALANCE,
C OPTING-OUT WILL OCCUR IN THE NEXT YEAR
C
      LAST1=LAST-1
      DO 30 J=2,LAST1
      K=LAST-J
      IF (OSDEBT(K) .GE. 0.0) GO TO 35
   30 CONTINUE
   35 CONTINUE
      OPYEAR(I)=K+1-GRDYR-GRACE
      L=K+1
C
C ADJUST PAYMENT REQUIRED IN THE OPT-OUT YEAR
C
      IF (M .EQ.1) GRDPAY(I,L)=OSDEBT(K)*(1.+OPRATE)
      IF (M .EQ.2)  DOPAY(I,L)=OSDEBT(K)*(1.+OPRATE)
      L1=L+1
C
C  NO PAYMENTS MADE AFTER OPT-OUT YEAR
```

```
      DO 40 N=L1,LAST
      IF (M .EQ. 1) GRDPAY(I,N)=0.0
      IF (M .EQ. 2)  DOPAY(I,N)=0.0
   40 CONTINUE
      IF (M .EQ. 1) GRDCP(I)=CPYEAR(I)
      IF (M .EQ. 2)  DOOP(I)=OPYEAR(I)
   41 CONTINUE
   50 CONTINUE
   90 CONTINUE
      DO 93 I=2,IDEC
      DOOP(I)=DOOP(1)
      DO 93 J=1,LAST
      DOPAY(I,J)=DOPAY(1,J)
   93 CONTINUE
   51 CONTINUE
C
C CALCULATE TOTAL (GRADUATES + DROPOUTS) REPAYMENTS
C
      DO 55 J=1,40
      REPAY(J)=0.0
      DO 55 I=1,IDEC
      REPAY(J)=REPAY(J)+GRDPAY(I,J)+DOPAY(I,J)
   55 CONTINUE
C
C  DETERMINE AGGREGATE CASH FLOWS USING TOTAL LOANS AND TOTAL REPAYMENTS MADE
C
C ASSUME NO DEATHS IN BORROWING PERIODS
C
      DO 65 I=1,GRDYR
   65 LOAN(I)=LOANYR*GRDDEC*SW
      IF (DODEC .EQ. 0) GO TO 67
      DO 66 I=1,DOYR
   66 LOAN(I)=LOAN(I)+LOANYR*DODEC*SW
   67 CONTINUE
      CALL CSFFLO (REPAY,YRPAY,GRACE,INRATE,LOAN,INTDUE,PRINPD,OSDEBT,
     1  CFLOW,GRDYR)
C
C
C     CUT OFF ITERATIVE PROCESS FOR THIS PROBLEM AFTER 60 ATTEMPTS TO FIND
C     AN APPROPRIATE VALUE FOR THE PARAMETER BEING SOLVED FOR )
C
      NUM=NUM+1
      IF (NUM .GT. 60) GO TO 919
      IF(NUM.NE.1)  GO TO 302
C
C     INITIALIZE ITERATIVE VARIABLES ( SIN,SST,STAU SAVE INITIAL VALUES OF ALL
C     PARAMETERS WHICH CAN BE SOLVED FOR)
C
      SIN(1)=INRATE
      SST(1)=START
      STAU(1)=TAU
      SIN(2)=0.
      STAU(2)=0.
      SST(2)=0.
      SAVE=OSDEBT(LAST)
  302 CONTINUE
      IF(NUM.LT.2)  GO TO 303
      SIN(2)=SIN(1)
      SIN(1)=INRATE
      STAU(2)=STAU(1)
      STAU(1)=TAU
      SST(2)=SST(1)
```

```
      SST(1)=START
  303 CONTINUE
C
      IF (ISTOP .EQ. 1) GO TO 200
C
C     IS CURRENT OUTSTANDING DEBT SUFFICIENTLY LOW TO TERMINATE ITERATIVE
C     PROCESS ? -- I.E. HAVE WE GOTTEN CLOSE ENOUGH TO THE VALUE OF THE
C     PARAMETER BEING SOLVED FOR ?
C
      IF (ABS(OSDEBT(LAST)) .LE. CONVG) GO TO 200
      IF(ICONT.EQ.1)  IF(ITAU) 91,70,91
      IF (IPART .EQ. 1 .AND. ITAU .EQ. 1) GO TO 91
      IF (IPART .EQ. 1 .AND. ICOUP .EQ. 1) GO TO 80
      IF (IFIXED .EQ. 1 .AND. ICOUP .EQ. 2) GO TO 70
      IF (IFIXED .EQ. 1) GO TO 80
   70 CONTINUE
      WRITE (6,953) INRATE,OSDEBT(LAST)
      ITER=1
      GO TO 401
   80 CONTINUE
      WRITE (6,943) START,OSDEBT(LAST)
      ITER=2
      GO TO 401
   91 CONTINUE
      WRITE (6,900) NUM,TAU,OSDEBT(LAST)
      ITER=3
  401 CONTINUE
C
C     DEPENDING ON WHAT IS BEING SOLVED FOR (RATE-OF-RETURN, STARTING PAYMENT
C     OR TAX RATE ) WILL HAVE TO CALL FINCR SLIGHTLY DIFFERENTLY
C
C
C     ARGUMENTS SENT TO FINCR
C
C             1. OUTSTANDING DEBT LAST ITERATION
C
C             2. OUTSTANDING DEBT THIS ITERATION
C
C             3. THIS ITERATION'S VALUE OF PARAMETER BEING SOLVED FOR
C
C             4. ARRAY WITH VALUES OF PARAMETER (THIS ITERATION AND LAST ITERATION)
C
C             5. INDICATOR TO SIGNIFY WHETHER NEXT ITERATION'S VALUE OF PARAMETER
C                HIGHER OR LOWER THAN ITS VALUE THIS ITERATION
C
C                   A. IF SOLVING FOR RATE-OF-RETURN, POSITIVE OUTSTANDING
C                      (TOO MUCH PAID IN) IMPLIES INTEREST RATE SHOULD BE LOWERED
C                      (INCR=2)
C
C                   B. IF SOLVING FOR TAU OR STARTING PAYMENT AND OUTSTANDING
C                      DEBT IS POSITIVE (TOO MUCH PAID IN) SHOULD REDUCE AMOUNT
C                      REPAID BY REDUCING TAU OR THE STARTING PAYMENT (INCR=1)
C
C
C     HAVE FOUND APPROPRIATE VALUE FOR PARAMETER BEING SOLVED FOR ; PRINT
C     HEADINGS AND THEN THE CASH FLOW SAVED FROM THE LAST ITERATION
C
      INCR=2
      IF(ITER .EQ. 1)INCR=1
      IF (ITER .EQ. 1 .AND. OSDEBT(LAST) .GT. 0.0) INCR=2
      IF (ITER .NE. 1 .AND. OSDEBT(LAST) .GT. 0.0) INCR=1
      IF (ITER .EQ. 1)INRATE=FINCR(SAVE,OSDEBT(LAST),INRATE,SIN,INCR)
      IF (ITER .EQ. 2)START =FINCR(SAVE,OSDEBT(LAST),START ,SST,INCR)
```

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      IF (ITER .EQ. 3)TAU   =FINCR(SAVE,OSDEBT(LAST),TAU ,STAU ,INCR)
      SAVE=OSDEBT(LAST)
      GO TO 21
  200 CONTINUE
      IF(IFIXED.EQ.1)WRITE (6,951) XGROW,START,YRPAY,GRACE,BORR,LOANYR,
     1 REQRT
      IF(ICONT.EQ.1)WRITE (6,905) OP,REQRT,YRPAY,GRACE,BORR,LOANYR,TAU
      IF(IPART.EQ.1)WRITE (6,950) XGROW,START,YRPAY,GRACE,BCRR,LOANYR,
     1 TAU,REQRT
  250 IF(IADV) PRINT 992,W
  992 FORMAT(' ADVERSE SELECTION PARTICIPATION BY FRACTIONS OF DECILE (A
     XSCENDING): ',10F5.3/)
      WRITE (6,945)
      DO 260 I=1,LAST
      IYEAR    =1970+UPINC+I
      WRITE (6,903) IYEAR    ,LOAN(I),REPAY(I),OSDEBT(I),INTDUE(I),
     1  PRINPD(I),CFLOW(I)
  260 CONTINUE
C
C     PRINT OPT-OUT YEARS IF WORKING WITH FULLY CONTINGENT PROGRAM
C
      IF (ICONT .EQ. 1) WRITE (6,902) (GRDOP(I),I=1,IDEC)
      IF (ICONT .EQ. 1) WRITE (6,906) DOOP(1)
      IF(IFIXED.EQ.1)    GO TO 301
C
C     COMPUTE AND PRINT CASH FLOWS FOR ALL DECILES IF DESIRED ( UP TO THIS
C     POINT HAVE COMPUTED ONLY AGGREGATE CASH FLOWS - EXCEPT IN COMPUTING
C     OPT-OUT YEARS IN FULLY CONTINGENT PROGRAM)
C
      IF (PRTDEC .NE. 0) GO TO 301
      DO 300 I=1,IDEC
      DO 1003 MMM=1,GRDYR
 1003 LOAN(MMM)=LOANYR*GRDDEC*W(I)
      IF (DOYR .EQ. 0) GO TO 312
      DO 311 MMM=1,DOYR
  311 LOAN(MMM)=LOAN(MMM)+LOANYR*DODEC*W(I)
  312 DO 310 J=1,LAST
      REPAY(J)=GRDPAY(I,J)+DOPAY(I,J)
  310 CONTINUE
      CALL CSHFLO(REPAY,YRPAY,GRACE,INRATE,LOAN,INTDUE,PRINPD,OSDEBT,
     1  CFLOW,GRDYR)
C
      IF ( ICONT .EQ. 1) WRITE (6,905) OP,REQRT,YRPAY,GRACE,BORR,LOANYR,
     1 TAU
      IF (IPART .EQ. 1) WRITE (6,950) XGROW,START,YRPAY,GRACE,BORR,
     1 LOANYR,TAU,REQRT
      IF (IFIXED .EQ. 1) WRITE (6,951) XGROW,START,YRPAY,GRACE,BORR,
     1 LOANYR,REQRT
      IF(IADV) PRINT 993,W(I)
      WRITE (6,944) I
      WRITE (6,945)
      DO 26 N=1,LAST
      IYEAR=1970+UPINC+N
      WRITE (6,903) IYEAR    ,LOAN(N),REPAY(N),OSDEBT(N),INTDUE(N),
     1  PRINPD(N),CFLOW(N)
C
C     IF PRINTING CASH FLOWS FOR PARTIALLY CONTINGENT PROGRAM, MARK HERE ANY
C     YEAR WHERE CONTINGENCY EXERCISE OCCURRED (GRAD SYMBOL = *, DROPOUT SYMBOL
C     = #)
C
      IF (IPART .EQ. 1 .AND. IMARK(I,N) .EQ. 1) WRITE (6,948)
      IF (IPART .EQ. 1 .AND. JMARK(I,N) .EQ. 1) WRITE(6,949)
   26 CONTINUE
```

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      IF (IPART .EQ. 1) WRITE (6,969)
  300 CONTINUE
  301 WRITE (6,946)
C
C     ICOUP = 1 IMPLIES THAT HAVE JUST SOLVED FOR STARTING PAYMENT IN PARTIALLY
C     CONTINGENT PROGRAM, WANT NOW TO COMPUTE COUPON RATE IMPLICIT IN THE
C     STARTING PAYMENT BEING USED IN THE OPTIONAL FIXED REPAYMENT SCHEDULE --
C     THUS SET ALL PARAMETERS TO DO THIS AND BRANCH BACK TO BEGIN ITERATION
C     PROCESS AGAIN
      IF (ICOUP .NE. 1) GO TO 919
      NUM=0
      ICOUP=2
      IPART=0
      IFIXED=1
      GO TO 21
  800 FORMAT (5F10.0)
  801 FORMAT (8F10.0)
  900 FORMAT (' ',I2,2X,F15.9,2X,F20.2)
  902 FORMAT ('0','OPT-OUT YEARS (BY DECILE OF MD''S , STARTING WITH THE
     1 LOWEST) : ',10(I2,'-'),'.')
  903 FORMAT (' ',I4,F16.2,F16.2,4(2X,F16.2,2X))
  904 FORMAT ('1',I5,/,' ',40(10F12.2,/))
  906 FORMAT ('0','OPT-OUT YEARS (FOR DROPOUTS) : ',I2)
  905 FORMAT ('1',51X,'FULLY CONTINGENT PROGRAM',/,'0',51X,
     1 'OPT-OUT RATE = ',F6.2,' %',/,52X,'REQUIRED RATE OF RETURN = ',
     2 F6.2,' %',/,52X,'REPAYMENT PERIOD = ',I2,' YEARS',/,52X,
     3 'GRACE PERIOD = ',I2,' YEARS ',/,52X,'TOTAL # OF BORROWERS = ',
     4 F8.0,/,52X,'LOAN PER YEAR = $ ',F7.2,/,52X,
     5 'REPAYMENT TAX RATE = ',F11.9)
  950 FORMAT ('1',51X,'PARTIALLY CONTINGENT PROGRAM',/,'0',51X
     1 'FIXED REPAYMENTS GROW AT ',F5.2,' %',/,52X,'FROM STARTING PAYMENT
     2 OF $ ',F6.2,/,52X,'REPAYMENT PERIOD = ',I2,' YEARS',/,52X,
     3 'GRACE PERIOD = ',I2,' YEARS',/,52X,'TOTAL # OF BORROWERS = ',
     4 F7.0,/,52X,'LOAN PER YEAR = $ ',F7.2,/,52X,'REPAYMENT TAX RATE ='
     5 ,1X,F11.9,/,52X,'INTEREST RATE = ',F7.4,'%')
  951 FORMAT ('1',51X,'SEMI-CONVENTIONAL LOAN PROGRAM',/,'0',51X,
     1 'FIXED REPAYMENTS GROW AT ',F5.2,'%',/,52X,'FROM STARTING ',
     2 'PAYMENT OF $ ',F6.2,/,52X,'REPAYMENT PERIOD = ',I2,' YEARS',/,
     3 52X,'GRACE PERIOD = ',I2,' YEARS',/,52X,'TOTAL # OF BORROWERS = '
     4 ,F7.0,/,52X,'LOAN PER YEAR = $',F7.2,/,52X,'INTEREST RATE = ',
     5 F7.4,'%')
  943 FORMAT (' ','START = ',F10.6,' DEBT = ',F12.2)
  944 FORMAT ('0','DECILE # ',I2)
  945 FORMAT ('0','CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :',/,
     1 ' ',40('-'),//,'0','YEAR',8X,'NEW LOANS',1X,'CURRENT REPAYMENTS',
     2 2X,'OUTSTANDING DEBT',6X,'INTEREST DUE',6X,'PRINCIPAL PAID',
     3 8X,'CASH FLOW',/,' ',4('-'),8X,9('-'),1X,18('-'),2X,16('-'),6X,
     4 12('-'),6X,14('-'),8X,9('-'),/,17X,'($)',12X,'($)',15X,
     5 '($)',17X,'($)',15X,'($)',17X,'($)',/)
  948 FORMAT ('+',36X,'*')
  949 FORMAT ('+',37X,'#')
  953 FORMAT (' ','RETURN = ',F10.8,' DEBT = ',F12.2)
  960 FORMAT ('1','CONTINGENCY EXERCISED BY DROPOUTS',/,'0',
     1 40(10(I2,1X),/))
  969 FORMAT ('-','* IMPLIES CONTINGENCY OPTION EXERCISED BY GRADUATES',
     1 /,' ','# IMPLIES CONTINGENCY EXERCISED BY DROPOUTS')
  999 CONTINUE
  989 STOP
  946 FORMAT ('1')
  993 FORMAT('+',T15,'FRACTION OF DECILE PARTICIPATING IN PROGRAM',F6.3)
      END
      SUBROUTINE CSHFLO(REPAY,YRPAY,GRACE,INRATE,LOAN,INTDUE,
     1 PRINPD,OSDEBT,CFLOW,GRDYR)
```

```
      REAL LOANYR,INRATE,LOAN(40),INTDUE(40)
      INTEGER YRPAY,GRACE,ENDPAY,GRDYR
      DIMENSION REPAY(40),PRINPD(40),CFLOW(40),OSDEBT(40)
      ENDPAY=GRDYR+GRACE+YRPAY
C BORROW AT BEGINNING OF YEAR
C REPAY AT END OF YEAR (EFFECTIVELY INCREASING GRACE PERIOD BY ONE YEAR)
      INTDUE(1)=LOAN(1)*INRATE
      PRINPD(1)=REPAY(1)-INTDUE(1)
      CFLOW(1)=REPAY(1)-LOAN(1)-INTDUE(1)
      OSDEBT(1)=LOAN(1)+INTDUE(1)
      DO 150 I=2,ENDPAY
      TOTLON=0.0
      TOTPPD=0.0
      DO 140 J=1,I
      TOTLON=TOTLON+LOAN(J)
      IF(J .EQ. I) GO TO 140
      TOTPPD=TOTPPD+PRINPD(J)
  140 CONTINUE
      INTDUE(I)=(TOTLON-TOTPPD)*INRATE
      PRINPD(I)=REPAY(I)-INTDUE(I)
      OSDEBT(I)=OSDEBT(I-1)+LOAN(I)-PRINPD(I)
      CFLOW(I)=REPAY(I)-LOAN(I)-INTDUE(I)
  150 CONTINUE
      RETURN
      END
      FUNCTION FINCR (S,O,F,PI,J)
      DIMENSION PI(2)
      S2=ABS(PI(1)-PI(2))
      S1=ABS(O-S)
      IF(S .EQ. O) GO TO 4
      IF(PI(2).EQ.0.) GO TO 4
      F1=(S2/S1)*ABS(O)
      GO TO 5
    4 F1=.05*F
    5 GO TO (1,2),J
    1 FINCR=F+F1
      GO TO 3
    2 FINCR=F-F1
    3 RETURN
      END
/*
//LKED.SYSLMOD DD DSN=U.P2133.PROGMLIB(NEWVER),UNIT=OLS,
// SPACE=(TRK,(10,5,1),RLSE),DISP=(NEW,CATLG,DELETE)
```

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